Sky and TELESCOPE

In This Issue:

Hadari w-al-Wazn

A Magnificent Eclipse

The Eclipse from the Air

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The Atmospheres of Jupiter and Saturn

Stars for August

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Vol. XIII, No. 10

AUGUST, 1954

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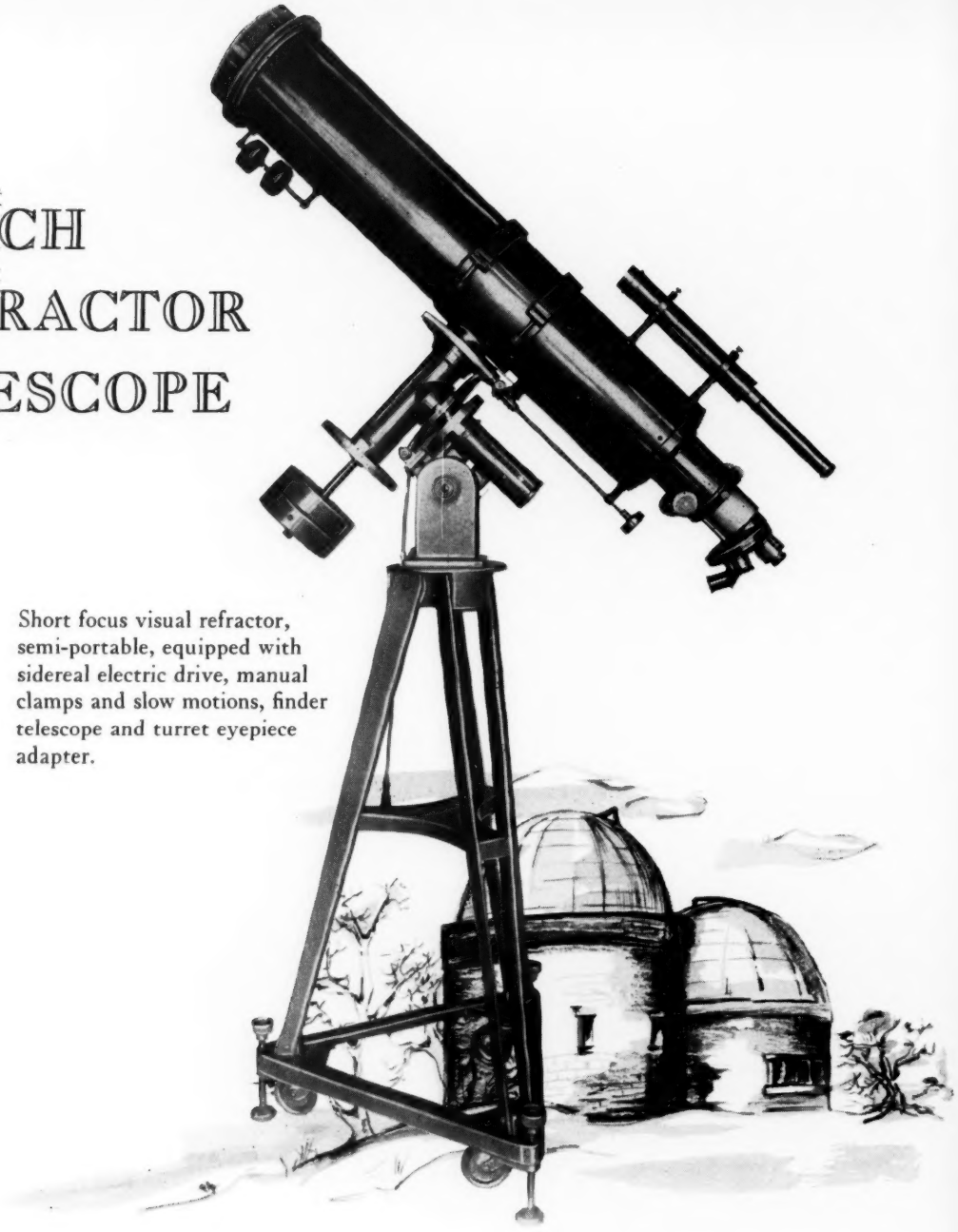

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Sky and TELESCOPE

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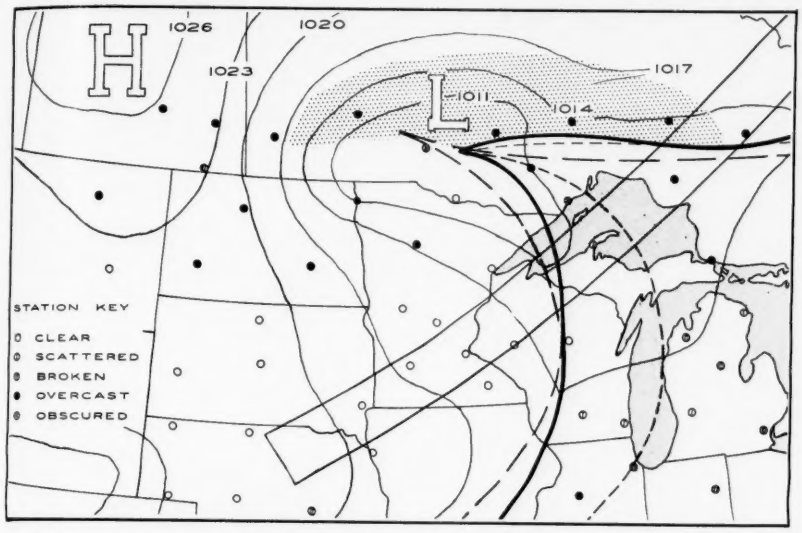

This map is adapted from a Minneapolis Weather Bureau working chart for 3:30 a.m. CST, June 30th. The fronts are shown by heavy lines; their 0:30 positions are marked by long dashes; 6:30 positions, by short dashes. Winds blow counterclockwise around the low; the rain area is dotted; pressures are in millibars. The path of totality is indicated.

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FEATURE PICTURE: A series photograph of the eclipse of June 30th shows the partial phases and the corona during totality. Photograph by Roy Swan, courtesy the Minneapolis Star 331

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The principal articles in SKY AND TELESCOPE, beginning with Vol. XII, are indexed in THE READERS' GUIDE TO PERIODICAL LITERATURE.

Total Eclipse Weather in the United States

ALTHOUGH the day before the eclipse, June 29th, dawned clear at Minneapolis, an overcast soon developed, and by 10 a.m. rain was falling. The whole region was covered by clouds, and scattered thunderstorms were predicted for the next day or two. The cloudiness continued throughout the day, but local Weather Bureau observers nevertheless found reason to hope for clear skies at eclipse time.

P. W. Kenworthy, meteorologist-in-charge at the USWB airport station, Wold-Chamberlain Field, later described to the editors of **Sky and Telescope** the sequence of events that culminated in beautifully clear skies over South Dakota, Minnesota, and Wisconsin during the eclipse, as follows:

As early as Sunday, June 27th, a trough disturbance lay over the Rockies, and on Monday moved rapidly to the eastern Dakotas. There the frontal movement petered out, while a second front formed to the west and moved to where the first had been; this second front was generated by a new surge of cool air aloft in the western Dakotas. Thus, between Monday and Tuesday the front did not seem to have been displaced at all.

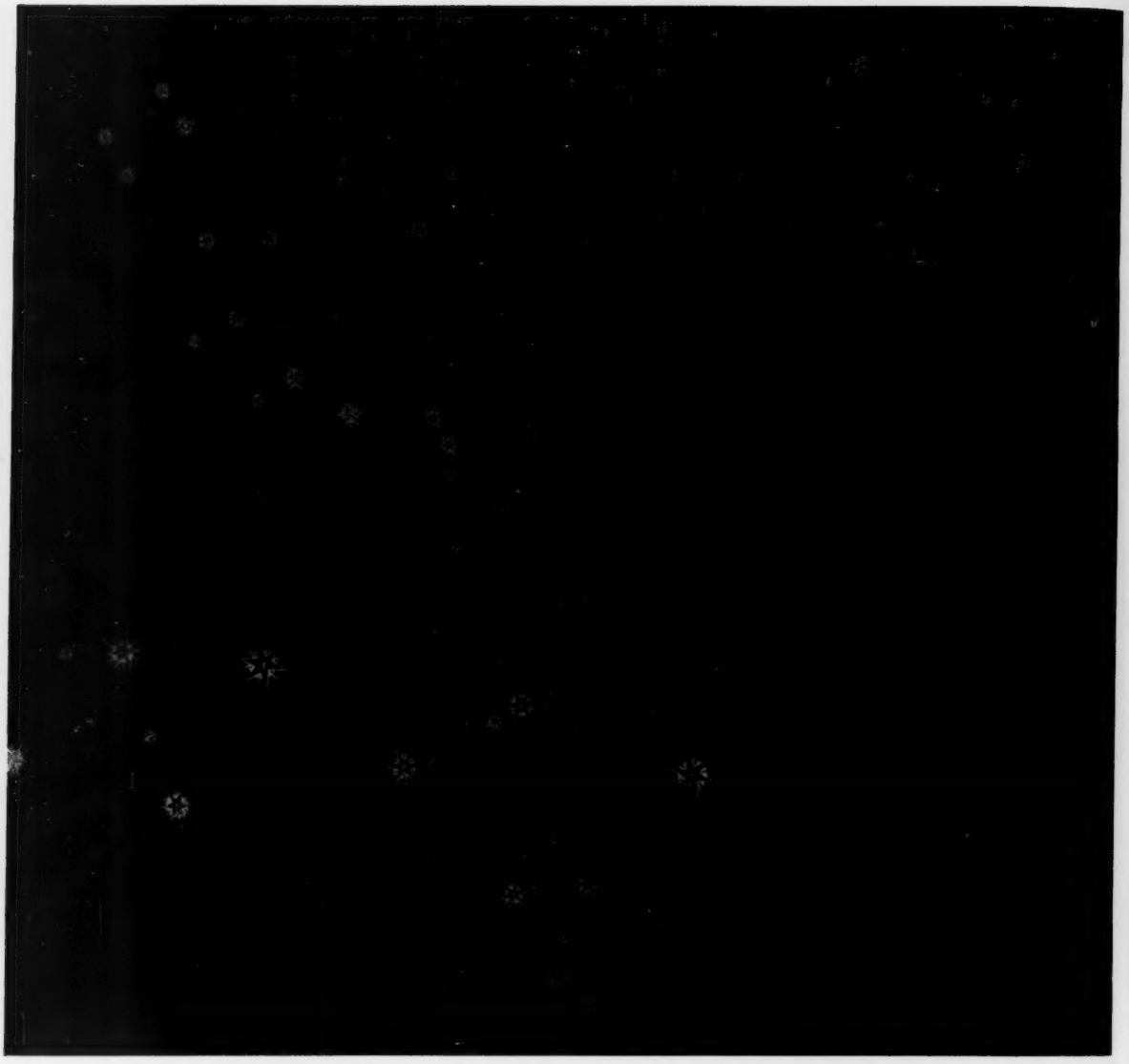
Meanwhile, to the north a gradually forming low pressure area west of Winnipeg began to move slowly eastward, accompanied by cloudiness along the warm front that extended eastward from the low center. By Tuesday noon, the winds behind the cold front accelerated and the front "took off," beginning a rapid motion eastward that was to carry it well across Lake Superior by eclipse time the next day. The low center was situated as shown on the accompanying chart for conditions about 1½ hours before totality, having been intensified by the movement of the cool air spiraling around it.

Thus, before early Tuesday, with conditions seemingly stagnant and Minneapolis in the warm sector of the pressure system, only a gloomy forecast could be made for the following morning. But by afternoon of the 29th, it was evident that there would be clear skies at the Twin Cities following the thunderstorms and showers as the cold front passed.

The most serious problem was to forecast the amount and arrival time of clouds caused by the "backwash" of air flowing around the north or top of the low center. This was sure eventually to bring clouds to areas west of the cold front, and such cloudiness is shown on the map already established in North Dakota and northern Minnesota, except at Duluth.

However, in his 9 p.m. and later broadcasts, Mr. Kenworthy definitely predicted clear skies for points in southern Minnesota and along the path of totality toward the Wisconsin-Michigan border. He was correct, but the closeness of bad weather is indicated by the 5:30 a.m. report from Alexandria, Minn., shortly after totality, of overcast at 1,700 feet.

(Continued on page 358)



The constellation of Centaurus, as depicted by Johann Bayer in his famous "Uranometria" of 1603. Since then, the designations of several stars in Centaurus have been changed: Beta Centauri is today the star in the right forefoot, here labeled Gamma (γ). The bright stars in the Centaur's hind feet now form Crux, the Southern Cross.

HADARI w-al-WAZN

By George A. Davis, Jr.

THE ANCIENT Arabic names of Alpha and Beta Centauri, and sometimes of Alpha and Beta Columbae, *HADARI w-al-WAZN*, have caused much difficulty to students of star names, both with regard to the correct translation of *Hadar* and the reason the two stars were so called. To my knowledge, satisfactory answers to these questions have never appeared in the astronomical literature.*

The meaning of *al-Wazn*, "the weight," is perfectly clear; but why is it always preceded and accompanied by *Hadar*, and how is it to be interpreted? Note that the word *Hadar* is not preceded by the Arabic article *al*. This fact alone should have been sufficient notice to the student that the name, perhaps, was not after all a proper noun. Ideler noticed this, but instead of helping him to the correct translation, it caused him to proceed on a tangent which led him far from the truth. All Arabic names of stars which consist of one proper noun, with the exception of *Suhail*, are preceded by *al*. This name is not. What then does it mean?

Let us first see what the great writers on Arabic star names have to say. The manuscripts of al-Sufi, al-Biruni, al-Qazwini, and others, do not, of course, include diacritical points and marks to indicate what vowels are to be used and where, and the translator, therefore, must fill them in with their correct values, and so arrive at a reasonable and acceptable translation.

The fact that these names were applied to two different sets of stars need not disturb us. There were several Arabian tribes, you know, and they

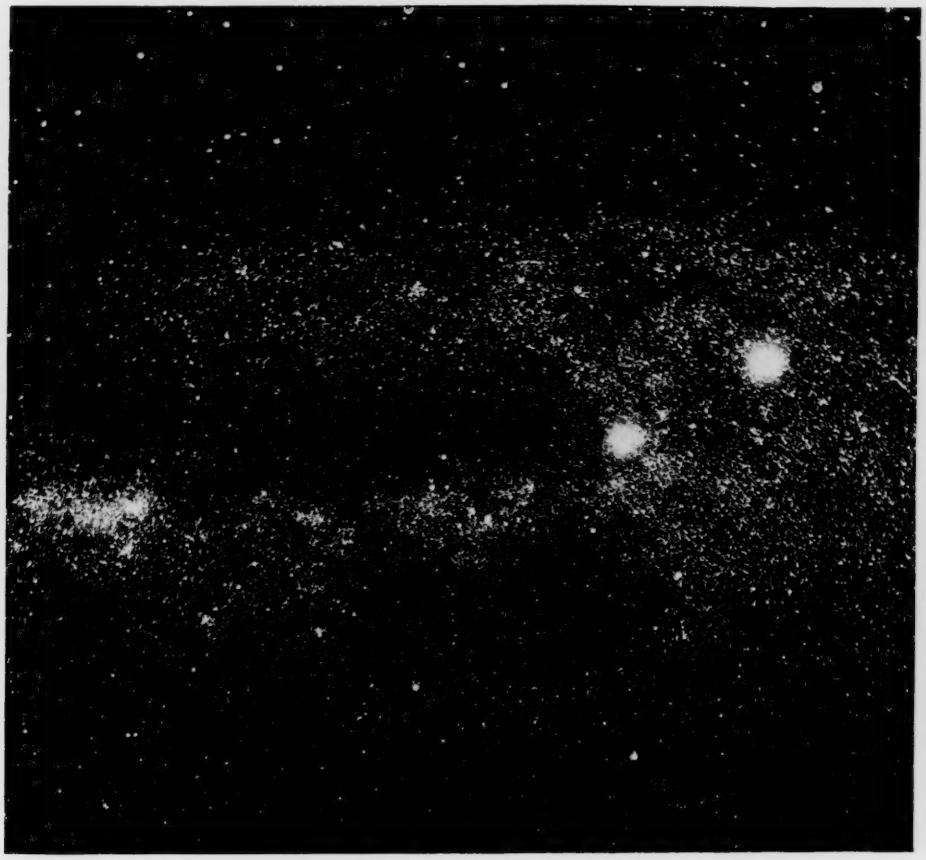
*In this paper it should be remembered that the Arabic letters *hha* and *dad* are pointed below and that the second *alif* is long. And the erroneously transliterated form *Hadar* is used throughout the greater part of the article.

did not always see eye to eye. Al-Sufi mentions on several occasions the fact that many Arabs, who did not really know the stars, frequently assigned wrong names to them. We are concerned, therefore, only with Alpha and Beta Centauri, although the same remarks could apply equally well to the other pair.

garded as precursors of its rising, is unimportant for the purposes of this paper. The meaning of *Suhail* and the traditions surrounding that great star will be considered at some future time.

Hyde, Ideler, Buttman, Sedillot, and other famous scholars and orientalists, writing in the 17th, 18th, and 19th centuries, assumed that the names had been entirely lost to the Arabs themselves by the 10th century, and both he and al-Qazwini were as puzzled by them as were their later commentators.

Hadar, which I shall now write correctly, *Hadari* (pronounced *hah-dah-ree,* with the accent on the second syllable) is not a simple noun, but an imperative



In this Milky Way picture, from a Harvard Observatory sky-patrol photograph, are portions of the southern constellations of Centaurus, Circinus, Lupus, Musca, Norma, and Triangulum Australe. The greatly overexposed star images in the right center are Alpha Centauri (left) and Beta Centauri, 1st-magnitude stars five degrees apart in the sky. They lie close to declination −60°, thus being scarcely visible at Cairo, which is at latitude 30° north. Because of precession of the equinoxes, however, they were about four degrees farther north 1,000 years ago, hence could more easily be seen from the Arab world.

Al-Sufi, our oldest authority, writing in the 10th century, says that the Arabs call α Centauri, "situated at the extremity of the right forefoot of the beast, and β, which precedes α, and which is found on the hock of the left forefoot, *Hadar* and *al-Wazn.*" He adds this significant paragraph, to which I shall refer later: "I do not know, however, which star is *Hadar* and which is *al-Wazn*, but it is probable that β is *Hadar* because it rises before α, and, furthermore, when the stars are referred to, *Hadar* is always mentioned first and then *al-Wazn.*" And then he concludes with the stock phrase: "But Allah knows better than we which is the truth!"

Al-Qazwini, three centuries later, without attempting any explanation of names, calls α *Hadar* and β *al-Wazn.*

We gather from both authors, however, that the rising of these two stars was an important event to the ancient Arabs; and whether one of them was mistaken for *Suhail,* or both were regarded as precursors of its rising, is unimportant for the purposes of this paper. The meaning of *Suhail* and the traditions surrounding that great star will be considered at some future time.

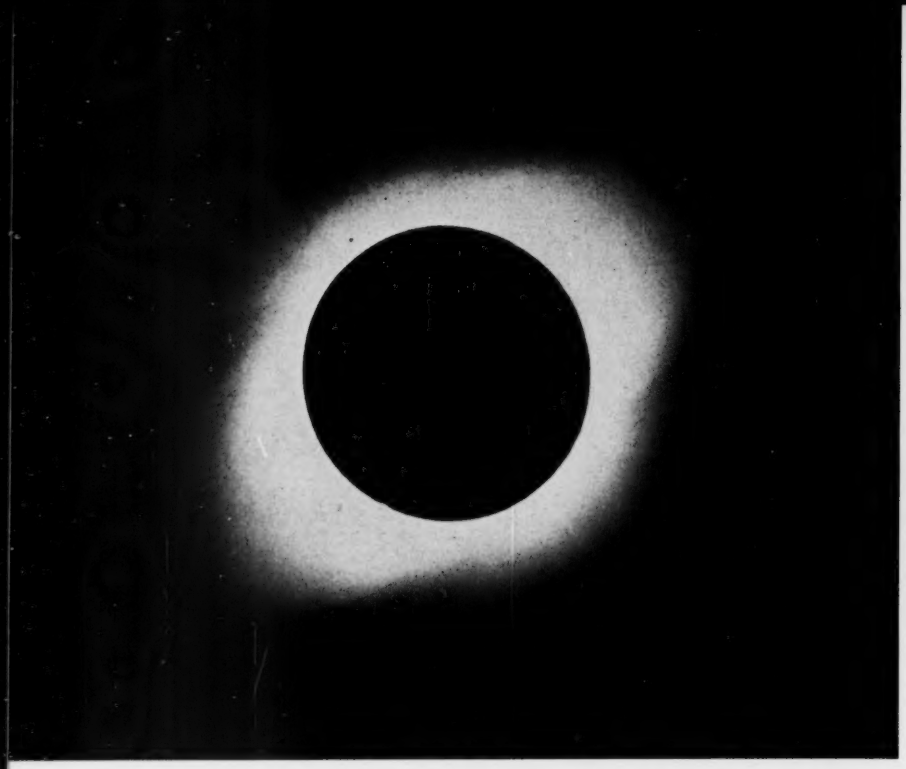
Hyde, Ideler, Buttman, Sedillot, and other famous scholars and orientalists, writing in the 17th, 18th, and 19th centuries, assumed that the names had been entirely lost to the Arabs themselves by the 10th century, and both he and al-Qazwini were as puzzled by them as were their later commentators.

Hadar, which I shall now write correctly, *Hadari* (pronounced *hah-dah-ree,* with the accent on the second syllable) is not a simple noun, but an imperative verb, meaning "Be thou present!" or "Hurry, appear quickly!" In other words, the Arabs *commanded* Beta Centauri to appear immediately, and since it did not rise quickly enough to satisfy their anxiety, they called Alpha *al-Wazn,* "the weight," because it seemed to hang on to Beta and prevent it from rising. The names, therefore, tell a complete story, and have nothing whatever to do with the altitude of the stars above the horizon.

Strange, bizarre, and remarkable star names? Yes, indeed, even when you know what they mean.

SKY AND TELESCOPE ON MICROFILM

Microfilm copies of back volumes of **Sky and Telescope** can be obtained from University Microfilms, 313 N. First St., Ann Arbor, Mich., to which all inquiries should be sent. The sale of the microfilm edition is limited to subscribers to **Sky and Telescope.**



This picture of the corona was taken by D. C. Dornberg, exposure time four seconds on Superpan Press film. He used a 3-inch lens of 54 inches focal length. St. Paul Dispatch and Pioneer Press photograph.

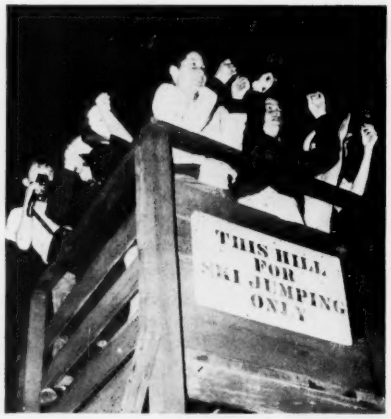
A Magnificent Eclipse

LONG-AWAITED, the total eclipse of the sun on June 30th was as awe-inspiring as any of its predecessors. Experienced eclipse observers and first-timers agreed on its magnificence, on the beauty of its pastel colorings, and on the strangeness of the fleeting seconds of totality.

The weather, described on page 327, followed the pattern of long-time averages across the United States and Canada: clear from Minnesota to extreme western Michigan, foggy on the Keweenaw peninsula, and steadily deteriorating farther eastward. Clouds interfered seriously with scientific work in Canada, Greenland, and in Iran, but at least some of the expeditions to Scandinavia were successful. An unprecedented number of amateur and professional scientists viewed the eclipse from airplanes, and special equipment was carried aloft by balloons.

Hundreds of thousands of observers situated in the completely clear region from the beginning of the track in Nebraska to Michigan saw all phases of the eclipse, from the partial obscuration of a rising sun through the dazzling brilliance of the diamond ring and the glory of the corona. Amateur photographers in this region had a field day. Many of them caught the moon's shadow clearly outlined against a sky still slightly hazy from stormy weather that had passed off eastward — a shadow forming a wedge in the heavens with its narrowest part at the horizon.

More millions far outside the path of totality were able to see the corona in their living rooms, thanks to television. The image picked up by the television cameras was projected by the 10½-inch refractor of the University of Minnesota, operated by Dr. W. J. Luyten, and was broadcast live by the Columbia network. As the moon blotted out more and more of the sun, views of the eclipse were interspersed with scenes of crowds watching the spectacle,



The platform at the top of a ski jump gave a fine vantage point. Photograph by Minneapolis Star.

and by a filmed explanation of the event by Dr. Luyten. Despite some technical difficulties, the brief and splendid beauty of totality was carried to the television audience.

The corona, whose exact appearance cannot be predicted in advance, was a fine example of the sunspot-minimum type, its inner parts looking much like the right side of the drawing on page 253 of the June issue. The coronal spikes at the sun's poles were conspicuous, and as many as four prominences were seen by some observers, one of them distinctly double.

According to Dr. J. J. Nassau, Warner and Swasey Observatory, who observed from an airplane 12,500 feet above Eagle Harbor, Mich., Baily's beads were visible for eight seconds before totality, followed briefly by the diamond ring effect. The diamond is made by the last bit of direct sunlight, which appears very bright to the eye but is not too bright to hide the inner corona that forms the ring. As the diamond fast fades out, the entire corona grows into view. Dr. Nassau called it "a very pale light blue," while others saw it as pinkish gray, pearly gray, and lavender gray.

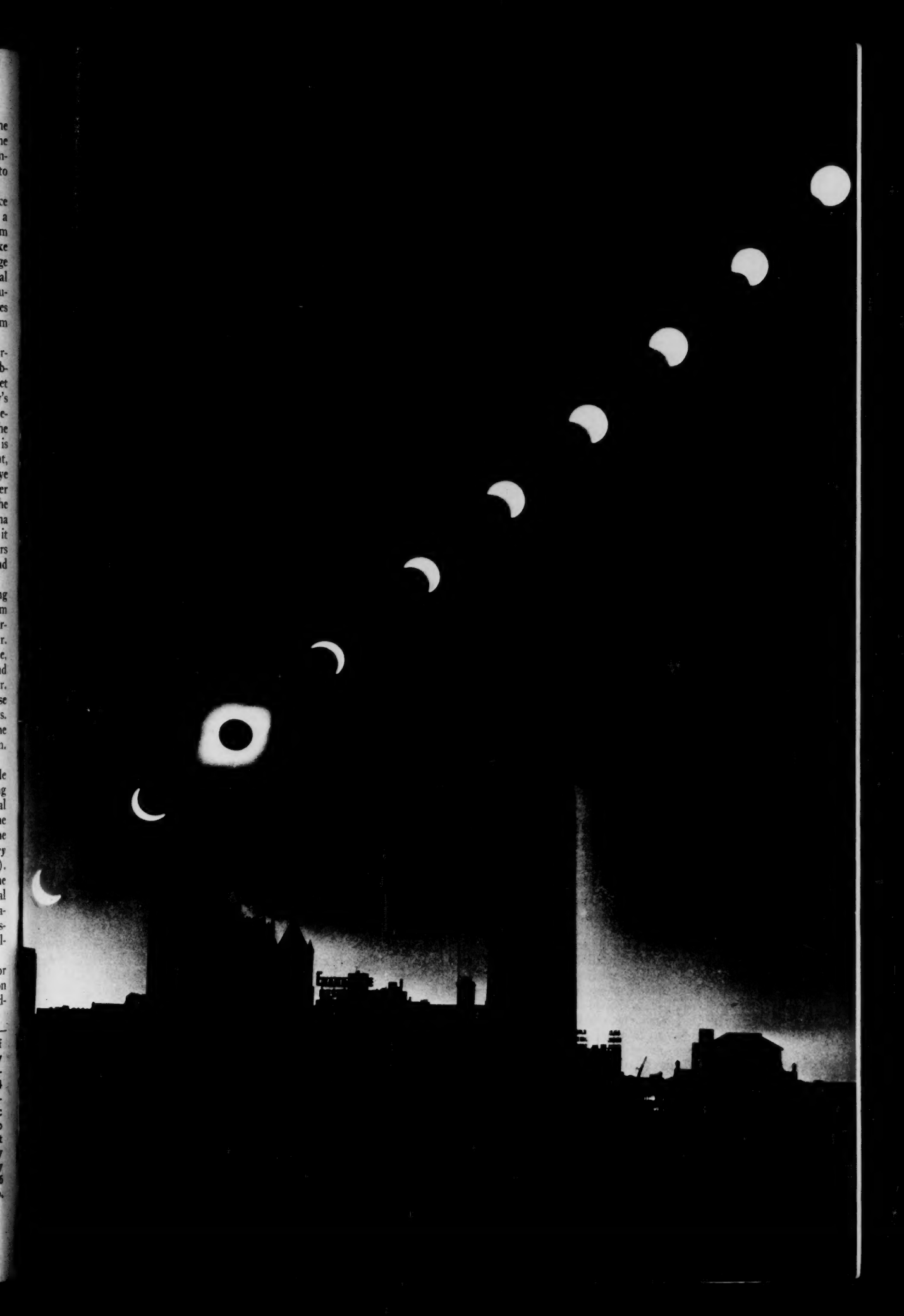
The coronal streamers were long cones, stretching millions of miles from each side of the sun's equator and tapering to fine points. During totality, Dr. Nassau writes, the sky was a deep purple, and the stars Capella, Aldebaran, and Theta Aurigae were seen. With Dr. Nassau were eight persons from Case Institute of Technology, including Drs. S. W. McCuskey and V. Blanco. The plane left Cleveland airport at 3 a.m. and returned nonstop at 10 a.m.

Very extensive plans had been made by the U. S. Air Force for precise timing of the eclipse at sites in 10 principal areas from Canada to Iran, for the purpose of determining the size of the earth more accurately than before (*Sky and Telescope*, May, 1954, page 215). The moon's shadow sweeps across the earth at a known speed; if the interval of its passage at two well-separated stations can be accurately timed, the distance between the stations can be calculated.

The Air Force program called for three methods of observation: motion pictures of the flash spectrum, the Lind-

(Continued on page 354)

FACING PICTURE: From the roof of the Plaza Hotel in Minneapolis, Roy Swan took this multiple-exposure photograph of the eclipse, beginning at 4:54 a.m. CST, and continuing at seven-minute intervals. He used a Speed Graphic camera fitted with a 12-inch telephoto lens. Exposures were 1/200 second at f/22 through a No. 4 neutral-density filter during the partial phases; totality was caught with 1/50 second at f/5.6 using no filter. Minneapolis Star photo.



Amateur Astronomers

Conventions at Worcester, Pittsburgh, and Fresno

WORCESTER, Mass., was the scene of the May 14-15 meeting of the Northeast Region of the Astronomical League, guests of the Aldrich Astronomy Club at the new home of the Museum of Natural History.

On Friday evening, astronomical movies were shown. Next morning at the opening session, representatives of 10 member organizations reported. The Schenectady Astronomy Club showed the largest gain in membership, with 40 new members bringing the present total to 92. The host society took the honors in activity, with the completion of its observatory. The report of the regional chairman, the undersigned, showed that we have 18 member organizations with 1,127 members, 364 junior members, and six members-at-large, based on last year's figures. The Fairfield County Astronomical Society, South Norwalk, Conn., joined the league during the year, and another society, the Central Connecticut Amateur Astronomers, of Middletown, has applied for membership.

The observer's session included papers on Mars, by Dr. Joseph Ashbrook; variable stars with periods from 100 to 150 days, by Dr. Dorrit Hoffleit; and lunar observations, by Frank J. Kelly. Lunch was served in the garden of the museum by the ladies of the Aldrich society. At the instrument session, James W. Gagan spoke on the Baker-Schupmann telescope design, and Stanley Brower showed a colored focogram of an objective lens, illustrating strikingly the residual chromatic aberration. Robert E. Cox spoke on image size and field of view.

A junior program, a new feature of Northeast conventions, was successfully presented under the direction of Dr. F. Shirley Jones, of Buffalo, N. Y., regional chairman of junior activities. Following the convention banquet, which was served at a nearby church, John Patterson, of the Boston Museum of Science, outlined the present status of the museum's planetarium installation, and commented as colored movies of the construction of the Korkosz projector were shown. It is hoped that Boston's Hayden Planetarium will open by late 1955.

That evening we drove out to the new observatory built by the Aldrich society. The building, with its fine club room and large reflector, had been dedicated just the week before.

Newly elected officers for the region are: chairman, Dr. Leon Storz, Worcester; vice-chairman, Bruce Neuffer, Schenectady; secretary, Mrs. Fay Bottomley, Worcester; treasurer, John Welch, Springfield. The 1955 Northeast convention will be held April 23-24 at Troy, N. Y., where the Astrophysical Society of the Rensselaer Polytechnic Institute will be host.

Clarence E. Johnson
102 State St.
Schenectady 5, N. Y.

SEVENTY-FIVE representatives of the Middle East Region of the Astronomical League attended a three-day convention at the Buhl Planetarium in Pittsburgh, Pa., May 28th to 30th.

After registration on Friday evening, those present attended a sky show, "By Rocket to Mars," as guests of the planetarium staff. The effects were so realistic that many of us felt we were seeing the world of tomorrow through our grandchildren's eyes.

Saturday's program began at 10 o'clock with a casting demonstration by C. Raible in the Amateur Astronomers Association workshop. Starting with bare patterns, Mr. Raible explained each step as he built up the cope and drag, made his molds, and poured melted aluminum from his homemade furnace. He later passed around a newly cast eyepiece holder for our inspection.

Following the business meeting, Owen Ranck, Milton, Pa., of the Association of Lunar and Planetary Observers, discussed planetary observing programs for amateurs.

The afternoon meeting opened with an instrument session featuring a panel of experts. Paul W. Stevens, of the Rochester Academy of Sciences, delivered an illustrated talk on the 1954 total eclipse. He, Jack Smith, and Bennett Cleveland were guests from the Northeast Region. Dr. T. H. Dunkelburger, of the chemistry department, University of Pittsburgh, gave the latest information on the chemistry of the stars in an easily understood manner appreciated by the whole audience. This was followed by the junior session.

New officers were then elected: chairman, P. Nash Anderson, Norfolk, Va.; vice-chairman, R. Thomas LuCaric, Baden, Pa.; secretary, Adam L. Ott, Jr., Pittsburgh; treasurer, Charles Strull, Louisville, Ky.; regional representative, Beaufort S. Ragland, Richmond, Va.

A special feature was the silver anniversary banquet, celebrating the 25th birthday of the Amateur Astronomers Association of Pittsburgh. The speakers included Chester Rowe, first president of the AAA, and Rolland R. LaPelle, league president. Carroll E. Beatty, of the Detroit Astronomical Society, was winner of a Skyscope, presented as a door prize by the manufacturers.

After the banquet, the conventioneers went to Allegheny Observatory in Riverview Park, where the 30-inch Thaw and the 13-inch refractors were open for visual observing. Also for visitors' use was a 6-inch special-design Fecker telescope on the observatory lawn.

On Sunday morning we were the guests of J. W. Fecker, Inc., for guided tours through the plant. This company, founded by John A. Brashear, is famous for its telescopes and other optical instruments.

Following the official close of the convention, 22 out-of-town visitors gathered at the writer's home for picnic supper and—of all things—several hours of observing with my 6-inch reflector.

Charles H. LeRoy
621 Saxonburg Rd.
Pittsburgh 15, Pa.

THE FIRST spring conference of the Western Amateur Astronomers was held at Fresno, Calif., on June 5-6, when some 125 amateurs from California, Arizona, Nevada, and New Mexico were guests of the Central Valley Astronomers.

The feature speaker of the conference was Clyde Tombaugh, discoverer of the planet Pluto, who gave the Morrison lecture of the Astronomical Society of the Pacific, on "The Planet Mars." Mr. Tombaugh explained his interpretation of the canals as crustal fractures caused by impacts of asteroidal bodies.

Two panel discussions were held, one Saturday afternoon on observing methods, the other Sunday morning on telescope optics and construction. The topics included photography for the amateur, by Dr. C. P. Custer; off-axis telescopes, by Mr. Tombaugh; observing Mars, and mirror polishing, by T. R. Cave, Jr.; filar micrometers, by R. Bohannon; the amateur's telescope, by C. Wells; apodizing screens and various factors affecting telescope performance, by A. Leonard; and mountings, by G. Carroll and C. Carpenter, the latter discussing large instruments, 15 to 18 inches in diameter.

The star party was held the evening of June 5th at the Central Valley Astronomers' mountain observing site on Patterson Seven Falls Ranch, 50 miles north of Fresno and 3,200 feet above sea level. About 35 telescopes were set up, ranging from two to 12½ inches. It was planned to have everyone make a drawing of Mars for later comparison, but the seeing proved too poor.

An announcement of our August 27-29 San Francisco convention appears on the facing page.

G. M. Reavis
626 W. Lamona
Fresno 5, Calif.

WESTERN AMATEURS SAN FRANCISCO CONVENTION

THE SIXTH annual convention of Western Amateur Astronomers on August 27-29 will be at the Josephine D. Randall Junior Museum, Roosevelt Way and 16th St., in San Francisco. Registration begins Friday morning.

There will be a star party in Marin County Friday evening, and a banquet late Sunday to close the convention. Some of the important Saturday papers will be given in the evening, for the benefit of those who cannot be present during the day. More papers will be presented Sunday morning.

Convention headquarters will be at the YMCA, 220 Golden Gate Ave. Men can be housed at the YMCA club house, women and married couples at the nearby YMCA hotel. Rates at both are $2.00-$2.25 per night, or $1.50 for two in a room. Dormitory accommodations for men can be arranged at $1.25 per night. Special buses will take the guests to the museum for sessions. The registration fee is $2.00, but need not be paid in advance.

A bus will be available for taking people to the star party, if there is enough demand. Dinner on Friday will be at the star party.

Those attending are urged to bring exhibits: instruments, tools, photographs, drawings, charts, or old books.

All correspondence should be addressed to the executive secretary of the convention, Miss H. E. Neall, 1626-A Chestnut St., Berkeley 2, Calif.

THIS MONTH'S MEETINGS

Chicago, Ill.: Burnham Astronomical Society. Aug. 7, 8 p.m., 14th annual observation party, home of Mr. and Mrs. H. C. Torreyson, 13 E. Palatine Rd., Prospect Heights.

Dallas, Tex.: Texas Astronomical Society. Aug. 23, 8 p.m., field meet, home of Ted F. Gangl, 7903 Mohawk Drive.

Lake Charles, La.: Lake Charles Amateur Astronomers Club. Aug. 10, 7:45 p.m., High School. Film, "Exterior Galaxies."

HONOLULU SOCIETY

The Hawaii Astronomical Society holds meetings on the third Tuesday of each month at 7:30 p.m., in Cottage 36, McKinley High School. There are lectures on astronomy, and telescope time, at the meetings. The president is R. J. Terry. We have a fairly large, sober-minded group, interested in astronomy.

CLARKE A. DIGGS
Secretary-treasurer
1547 Ala Wai Blvd.
Honolulu, T. H.

ILLINOIS JUNIOR GROUP

The Arlington Heights High School Astronomy Club finished its first year at the end of the school year. We had about 20 members and expect more next season. Observing equipment includes two 6-inch reflectors, four 3½-inch reflectors, and smaller telescopes. We took several trips, the most important one to Yerkes Observatory.

LEE WATSON, president
603 E. Euclid
Arlington Heights, Ill.

ASTRONOMICAL SCRAPBOOK

THE SATELLITE OF VENUS

HOW MUCH confirmation do you need to place an observational discovery beyond any reasonable doubt? This is the important and disturbing question raised by the story of a satellite of Venus, which at one time was confidently accepted as a member of the solar system. No fewer than 33 observations of it by 15 different astronomers were recorded during the 17th and 18th centuries, beginning with F. Fontana at Naples on November 11, 1645. In the year 1761 alone, 18 observations of the object were made.

Some of these sightings were by well-known observers, who even today have a reputation for reliability. Thus G. D. Cassini, director of the Paris Observatory and discoverer of Cassini's division in Saturn's rings, wrote in his journal for August 28, 1686:

"At 4:15 a.m., while examining Venus with a telescope of 34 feet focal length, I saw at 3/5 of its diameter to the east an ill-defined light, which seemed to imitate the phase of Venus, but its western edge was more flattened. Its diameter was very nearly ¼ that of Venus. I observed it with attention for a quarter of an hour, when, on quitting the telescope for five minutes, I could not find it again, the dawn being too bright."

In 1773, the German astronomer Johann Lambert calculated the orbit of the satellite of Venus. He found that it revolved about its primary in 11 days five hours, at a mean distance of 66½ radii of the planet, in an orbit whose eccentricity was 0.195.

Widespread interest was aroused when Lambert announced these results to the Berlin Academy of Sciences. The king of Prussia, Frederick the Great, proposed that the satellite be named after his friend, the French astronomer-mathematician, Jean d'Alembert. The latter prudently declined the honor, explaining that his place on earth was so insignificant he had no ambition for one in the skies.

Yet nothing can be more certain than that no such sizable satellite exists. It has never been seen since 1768. Veteran observers of Venus such as Schroeter, William Herschel, and Maedler could not find it. More recently, E. E. Barnard, whose interest in satellites was marked, made many observations of Venus with telescopes up to the Yerkes 40-inch in size without finding any companion. Currently, scores of amateurs every year scrutinize Venus with telescopes more powerful than those with which the supposed satellite used to be seen, without coming upon this object.

Even in the last century, the satellite of Venus found a few champions. In 1875, a curious book, *Der Venusmond*, was published in its defense by the German, Dr. F. Schorr. He argued that the many failures to see it were due to a brightness variation, such that the satellite was normally so faint as to be invisible. Schorr's elaborate hodgepodge was more enthusiastic than critical, and soon sank into the vast abyss of forgotten semiscientific literature, without having cleared up the mystery.

What the old observers really saw was finally explained by Dr. Paul Stroobant, of the Brussels Observatory, then at the start of his career as the most distinguished Belgian astronomer of the last generation. In his memoir of 1887,* Stroobant reprinted in full all the original statements of the observers of the satellite of Venus, described the earlier hypotheses to account for the observations, and subjected all this to a searching examination.

In the first place, Lambert's orbit was clearly impossible, as it required the mass of Venus to be 10 times greater than it actually is. Next, the descriptions of the satellite were highly contradictory. Several accounts spoke of a large disk showing the same phase as Venus; some at least of these observations must refer to "ghosts" caused by reflections within the telescopes, which would be particularly noticeable for so bright an object as Venus. Other observers had described the satellite as starlike, and Stroobant, by calculating the positions of Venus at the dates in question, could identify in seven cases what star the observer had mistaken for a satellite. It is possible, though not certain, that the "satellite" seen by Roedkiaer at Copenhagen on March 5, 1761, was the planet Uranus — 20 years before its recognition by Herschel.

There remained little else of the observations except some statements so vague as to inspire no confidence. So final was Stroobant's critique that the one-time belief in a satellite of Venus has been almost forgotten by now.

J. A.

*Etude sur le satellite énigmatique de Vénus, forming part of Vol. 49 of the **Mémoires couronnés** of the Académie Royale des Sciences de Belgique, Brussels, 1887.

ANOTHER SUPERNOVA

At the Palomar Observatory, Paul Wild, who early in May had discovered a supernova in NGC 5668, found another on May 30th in NGC 4214. The new star was magnitude 12.5 at discovery, and is located 1.4 minutes of arc east and 3.6 minutes south of the nucleus of this irregular galaxy. The 1950 position of NGC 4214 is $12^h\ 13^m.1$, $+36°\ 36'$, and it appears at magnitude 10.3 visually.

The Eclipse from the Air

By Helen Hughes

Department of Astronomy
University of Minnesota

Light coming from outside the moon's shadow provides the principal illumination in this airport scene, made during totality while the Stratocruiser was aloft. Northwest Airlines photo by Don Berg.

EARLY IN 1954, representatives of Northwest Orient Airlines approached Dr. W. J. Luyten, chairman of the department of astronomy, University of Minnesota, with the idea that their company put a plane at the disposal of scientists to be named by him, for viewing the eclipse. He immediately took over the task, although he had decided that he must remain on the ground himself and take the 50-50 chance of clear weather. The Minneapolis 10½-inch refractor was the largest American observatory telescope along the path of totality, and Dr. Luyten had agreed to televise the eclipse through its lens.

Weeks of planning followed, in which airline personnel and Dr. Luyten studied the complex problems of fitting the plane to carry equipment, and choosing a flight course that would take viewers across the 70-mile-wide path during the partial phase, and return them to the central line for totality. There could be no leeway in the arrival times at any of the check points, so the flight officers and Dr. Luyten held three separate briefing sessions and rehearsals.

At 3:30 a.m. CST on the 30th, members of the expedition were served coffee at the Minneapolis airport. About 50 people were to make the flight; 15 were astronomers and physicists, while the rest were advanced amateurs, newspaper and radio people, and Northwest personnel. Dr. D. H. Menzel and other Harvard Observatory staff members, and Drs. C. E. Hesthal and A. N. Dingle, of Ohio State, were making planned observations, but most of the other scientists had brought only viewing equipment. This group included Dr. Harold Urey, University of Chicago; Dr. H. P. Wilkins, British Astronomical Association; Dr. R. Sutton, Haverford College; Dr. S. Plakidis, Athens Observatory; and Dr. J. W. Buchta, University of Minnesota, at present serving with the National Science Foundation.

The party boarded the plane at 4 o'clock amid mounting tension. For many of us it was our first total eclipse. Seat belts were fastened and at 4:15 the plane taxied down the field and took off. Soon we were gaining altitude by great spiral turns. At 20,000 feet, we leveled off and started the first leg of our flight, toward Northfield, Minn., which lay about a mile outside the path of totality.

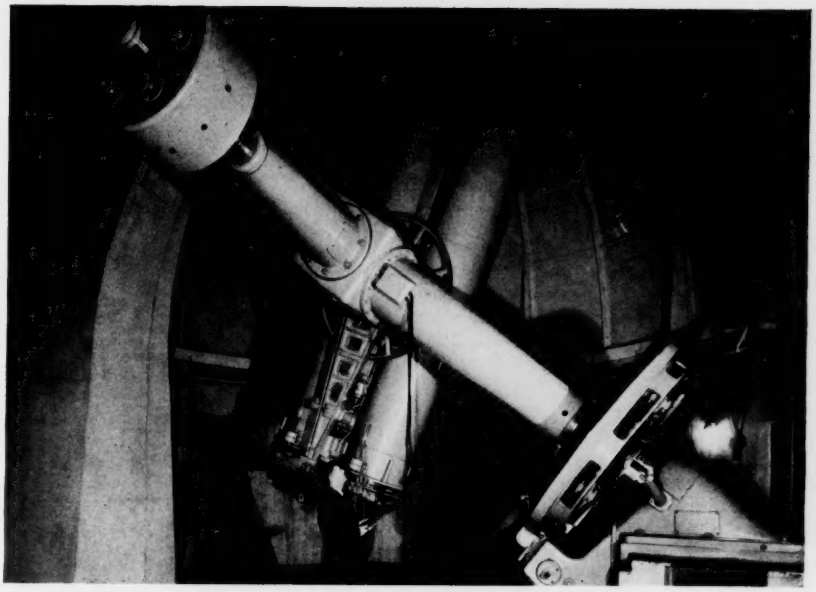
As the partially eclipsed sun rose at 4:29, a very peculiar refraction effect was seen, described by Dr. Buchta as "a bite out of a bite." This effect lasted a few minutes, but faded before the sun's lower limb cleared the horizon.

At 5:03 the plane circled Northfield and the last lap had begun. We were flying at 20,000 feet, magnetic heading 320°, at 120 knots, which would bring us over Lake Minnetonka, on the central line, at 5:07. Dr. Menzel spoke over the public address system, giving final instructions for those interested in each type of observation. He directed those who wished to observe the flash spectrum to start about five seconds before totality, made some suggestions to the photographers about exposure times, and advised the group that the seconds count would start at 5:07:00, and that totality would arrive at

(Continued on page 358)

Flying above Minnesota in a Northwest Airlines Stratocruiser, Dr. C. E. Hesthal, of Ohio State University, photographed the flash spectrum. St. Paul Dispatch and Pioneer Press photo.

First Series of Lick Survey Completed



The 20-inch Carnegie astrographic camera of the Lick Observatory. The second tube is designed to carry a second objective of the same size, for photography in red light. Lick Observatory photograph.

LICK OBSERVATORY has completed the first phase of a long-range sky-mapping program, planned primarily to investigate the rotation of our galaxy. Before the war, Dr. W. H. Wright, then director but now retired, conceived the project of photographing the entire sky north of declination $-23°$ with two-hour exposures on 17-by-17-inch plates showing faint galaxies. Unlike even very faint and distant stars, these galaxies form a practically stationary reference system, with respect to which the proper motions of stars in our own Milky Way system can be determined more precisely than has ever been possible before.

After the survey has been repeated several decades hence, measurements of the shifts of stars relative to the faint galaxies should give us highly accurate speeds of rotation of stars around the galactic center. There should be no detectable change in the positions of the reference galaxies within half a century.

For the survey, Dr. Wright designed a 20-inch astrographic camera, and obtained a $65,000 grant from the Carnegie Corporation. The form of the instrument reflects the demands of the observing program. Thus, since two-hour exposures on fields passing the meridian were intended, a long polar axis, supported at both ends, was chosen instead of a German-type mounting. Great pains were taken to minimize instrumental flexure, an insidious source of error in precise positional work. The Warner and Swasey Company built the telescope and mounting, while the quadruplet objective was made by J. W. Fecker, Inc., from designs by F. E. Ross. The building is shown on the front cover.

Although the instrument was nearly completed by the end of 1940, wartime delays intervened, and the first photograph for the program was obtained on April 10, 1947. The initial coverage of the sky required photographing 1,246 overlapping areas. As each plate was taken, it was promptly examined for interesting objects, and several comets and a number of asteroids with unusual motion were discovered as by-products of the survey. Dr. C. D. Shane, the present director of Lick Observatory, reported that the last plate was taken on March 4, 1954, with Dr. Wright present in the dome of the 20-inch.

Tests of the survey photographs show them well suited to the determination of stellar proper motions. Even in the corners of the large plates, the star images are quite small and symmetrical, and the positions of stars as faint as magnitude 17.5 can be reliably measured. The positions of galaxies with well-defined nuclei can be determined with a precision of ± 0.15 second of arc from the mean of two plates, nearly matching the corresponding figure for stars, ± 0.09 second.

Two methods have been used to extend this accuracy to stars as bright as 8th magnitude, which would otherwise be too overexposed to measure. All plates were taken with a coarse wire grating in front of the objective. The image of each bright star is thus flanked symmetrically by fainter, more readily measurable companion images, from which the place of the bright star can be inferred. The second procedure was, at the middle of every two-hour exposure, to shift the plate temporarily by a known slight amount and to make a one-minute exposure. Positions of very bright stars can therefore be obtained by measuring these auxiliary images, which are eight magnitudes fainter. The front-cover picture of *Sky and Telescope* for May, 1952, is part of a Lick survey plate, showing both the grating companions and the one-minute images.

The work of measuring the plates and discussing the motions will be carried out by Dr. Stanislaus Vasilevskis, of the Lick Observatory staff, a specialist in astrometry who received his training at the University of Riga, Latvia. The measurement of the photographs will be a much lengthier process than securing them. Before this stage of the program begins, a special new measuring engine will be obtained, which will cost about $50,000.

Future plans call for retaking some of the plates after the lapse of 10 or more years, in 1957-1959, to check on the accuracy of the proper motions that will finally be obtained. From that time on, the second-epoch plates will continue to be taken, but at a slow-enough rate to keep pace with the laborious work of measurement. It is expected that the last plates will be obtained about 1985, some 35 years after the corresponding first-epoch plates. This schedule is a compromise between lengthening the time interval separating the plates to be compared, which increases the accuracy of the proper motions, and maintaining steady progress in the measurements.

Meanwhile, the photographs that have already been taken are being exploited in another way. Dr. Shane and C. A. Wirtanen, who between them took nearly all of the first-epoch plates, are using them for a thorough analysis of the distribution of extragalactic nebulae. They have already shown that the galaxies have a much greater tendency toward clustering than had previously been realized.

Telescopic View of Jupiter and Moons

A striped pearl of opalescent hue,
Four tiny sparks of diamond facet-sheen,
A jeweled bracelet glittering on blue
And violet of space's velveteen.

WALTER W. STEPHEN

The Atmospheres of Jupiter and Saturn

By Otto Struve, *Leuschner Observatory, University of California*

More than a century ago, when Alexander von Humboldt summarized the astronomical knowledge of his day in his book *Cosmos,* he first drew attention to the now familiar distinction between the terrestrial planets — small, relatively dense bodies with little or no atmosphere — and the giant planets, marked by low densities and very extensive atmospheres.

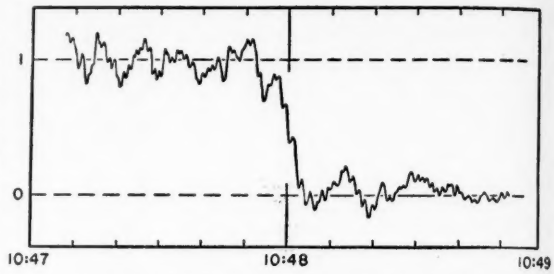
Among the giant planets, Jupiter and Saturn have for many years attracted particular attention, the former originally from the wealth of changing detail visible upon its disk in even small telescopes. Such features lie in Jupiter's atmosphere, which is so deep that nothing of the planet's solid surface can be seen through it.

Perhaps the most useful of the long-continued visual studies of Jupiter have been the determinations of individual rotation periods for many of the temporary cloud markings. This work has provided valuable observational data upon atmospheric circulation on Jupiter. However, such visual investigations have not led to much insight into the physical nature of Jupiter's atmosphere. Progress in this respect has begun only with the application to planets of the powerful astrophysical methods, both observational and theoretical, that have been so successful in stellar astronomy.

Among the earliest astrophysical studies of Jupiter were the observations by V. M. Slipher, at the Lowell Observatory in 1905-1909, of the great absorption bands in the red part of its spectrum. That these bands were due to methane and ammonia was suggested in 1931 by R. Wildt, then at Goettingen, and this suggestion was soon confirmed by T. Dunham, Jr., at Mount Wilson. Jupiter's atmosphere could then be pictured as containing much methane, somewhat less ammonia, probably large quantities of hydrogen, and nitrogen. Saturn's atmosphere is similar in composition, but contains less gaseous ammonia, because of its lower temperature.

During the past two years, interesting results have been obtained at Mount Wilson and at Lowell Observatory that enable us to understand some of the remarkable properties of the atmospheres of the two largest planets.

The first was the photoelectric observation with the 60-inch reflector of an occultation of Sigma Arietis by Jupiter on November 20, 1952, the star being hidden for nearly two hours. With a spectrometer set at the wave length of a strong violet absorption line of ionized calcium (the K line), W. A. Baum and A. D. Code measured the decrease in the light intensity of the star as it passed behind the atmospheric edge of the planet. The spectrometer acted as a monochromator, isolating the absorption line, which is very strong in the spectrum of Jupiter's reflected sunlight, but weak in the spectrum of the *B*5-type star. Thus, the contrast between Jupiter's disk and the star was reduced, and this made it possible to avoid most of the planet's glare.

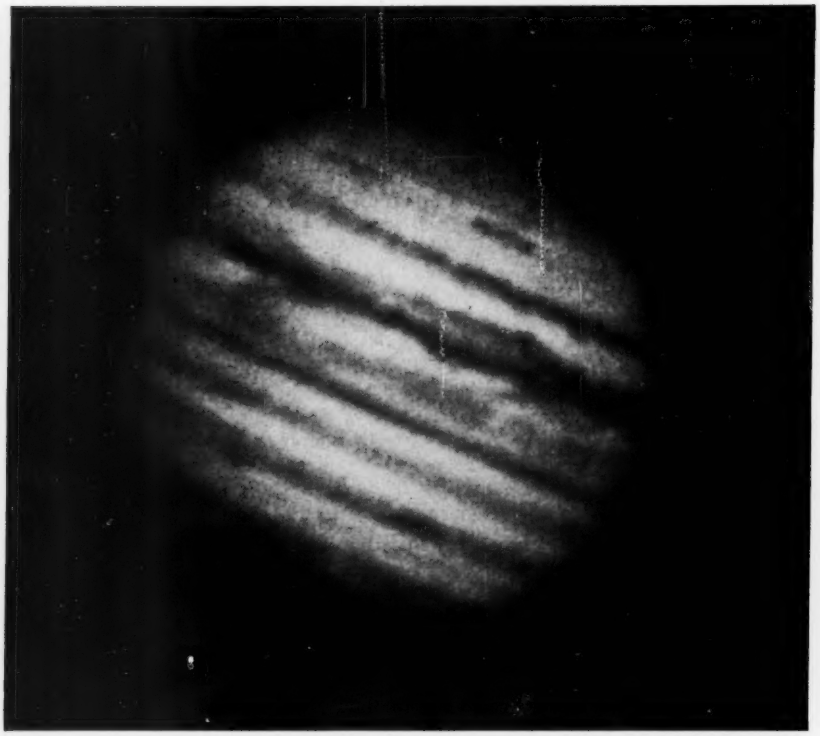


This light curve shows the fading of the star Sigma Arietis during its occultation by the atmosphere of Jupiter, November 20, 1952, as observed by Baum and Code. Universal time is given. From the "Astronomical Journal."

The decrease in the star's light at immersion was recorded on a moving strip of paper. The entire effect was brief. Baum and Code estimated that during the first six seconds the drop was one magnitude, or 2½ times, and that after 75 seconds the drop was five magnitudes, or 100 times.

Such occultations have been observed visually on rare occasions. What is new here is the interpretation. The fading of the star is almost entirely caused by the refraction of starlight in Jupiter's atmosphere, and is not due to scattering by molecules or by solid particles. The diagram opposite shows how the rays of a parallel bundle diverge after they pass through different layers of the planet's atmosphere. This divergence depends upon the index of refraction of Jupiter's atmosphere at various elevations above its cloud-layer surface.

Baum and Code were concerned with relative values of the index of refraction, making no measurements of the exact angular distance of Sigma Arietis above the surface of the planet. If this additional information had been available, they might have been able to derive the



The dark belts and light zones seen on the planet Jupiter are phenomena of its cloud-filled atmosphere. This is a 21-times enlargement from a Lick Observatory photograph by H. M. Jeffers.

absolute pressures of the atmosphere at different levels. But with a photometer it is not possible to measure distances; hence we must be satisfied with relative values of the pressure.

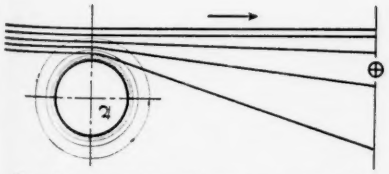
The indexes of refraction at two different levels are proportional to the densities of the atmosphere at those levels. These densities are, in turn, given by a barometric formula which tells us that the proportional change in the density, for a change in height of one centimeter, is $g\mu/RT$. Here, g is the surface gravity of Jupiter (2.65 times the earth's), μ is the mean molecular weight of the gas, R is the gas constant (8×10^7 for both Jupiter and the earth), and T is the absolute temperature (about ½ that of the earth's atmosphere).

The molecular weight of Jupiter's atmosphere depends upon its chemical composition. If we adopt the composition derived in 1937 by B. M. Peek, namely, six molecules of hydrogen (H_2) to one molecule of methane (CH_4), the average value of μ would be $(6 \times 2) + 1 \times (12 + 4) \div 7 = 4$. Since the atmosphere of the earth is mostly nitrogen (N_2) of molecular weight 28 and oxygen (O_2) of weight 32, the average for our own atmosphere is about 29. Jupiter's average molecular weight is therefore 4/29 that of the earth, or seven times lighter.

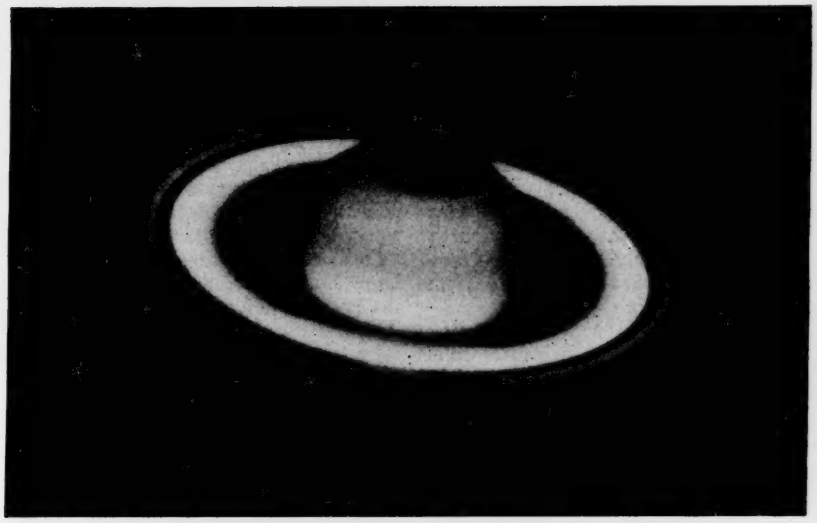
Let us substitute these relative Jupiter-Earth values for the quantities in the relative density formula, which comes out $2.65 \times 4/29 \div 1 \times ½$. This result may be taken as roughly equal to 1. It does not tell us how much the atmosphere of Jupiter actually weighs; it only shows that the ratio of Earth-Jupiter pressures is approximately the same for any given level in the atmospheres of the two planets.

In other words, in going from one level to another in Jupiter's atmosphere, the resulting percentage change of density (or pressure) would be very nearly the same as in the atmosphere of the earth.

The work of Baum and Code shows that the diminution of the star's light was, indeed, compatible with this theory. They find for the mean molecular weight in Jupiter's atmosphere 3.3, which is close enough to Peek's value of 4 to come within the permissible errors of the two sets of observations.



Parallel starlight diverges on passing through Jupiter's atmosphere. As seen from the earth, symbolized at the right, the increasing spreading of refracted starlight produced the fading of Sigma Arietis observed by Baum and Code. From the "Astronomical Journal."



This is a 22-times enlargement of Saturn, photographed on December 14, 1943, with the 36-inch Lick Observatory refractor.

The second result, by Seymour L. Hess, was first presented to a conference of planetary observers at the Lowell Observatory in 1951, and has been printed in the *Astrophysical Journal* (July, 1953). He has determined the amounts of methane and ammonia in different regions of Jupiter's and Saturn's visible disks.

Hess finds that there is actually less methane absorption near the limb of Jupiter than near the center. We should have expected stronger methane bands near the limb, just as in white light we observe the limb of the planet to be darker than the center. This darkening is caused by the oblique path through the atmosphere, approximately twice as long from regions 60 degrees on the planet from the subsolar point as it is at that point. Therefore, Hess' observation indicates that the atmosphere of Jupiter is shallower at the edge of the disk; apparently, the cloud layer is somewhat higher above Jupiter's surface near the limb than at the subsolar point. Let us estimate how much higher.

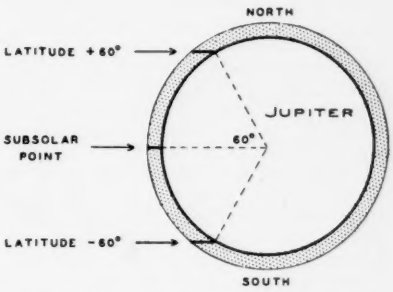
We can represent the amount of methane absorption by two factors: the path length of the light reflected from the cloud layer, and the partial pressure of methane as a constituent of the atmosphere. Assume, for the sake of argument, that the methane bands have the same intensities at the equator and at latitudes ±60°. To make up for a path length only half as long as that from the high latitudes, the light from the subsolar point would have to come from a level at which the partial pressure is twice that at the ±60° cloud level.

Already we have determined that the distribution of pressure above Jupiter is similar to that above the earth, except for a constant factor. Terrestrial atmospheric pressure of 760 millimeters of mercury at sea level drops to one half that value at an altitude of about four miles. Hence, four miles would be the difference in the heights of the cloud levels on Jupiter were the assumption of equal intensities correct.

Because the methane lines are actually weaker at ±60° than at 0° on Jupiter, and also because the pressure distribution is not exactly the same as on the earth, Hess calculates that the actual difference in level is about 10 kilometers. We can interpret this to mean that the midday heat of the sun (weak as it is on Jupiter) evaporates the upper strata of the cloud layer.

This difference in level of 10 kilometers could never be observed visually, even if it occurred along the limb, because it would correspond to only 0.004 second of arc. Hess estimates that the methane absorption method is sufficiently accurate to measure differences of elevation of the order of 1/10 this amount.

For ammonia (NH_3) Hess finds, again, that the bands are slightly weaker at high latitudes than at the equator, and they are *much* weaker near the morning limb. At the evening limb, on the other



The heavy lines indicate subsolar and high-latitude paths of sunlight as it traverses the atmosphere of Jupiter, assuming the sun is over its equator.

hand, they are nearly as strong as at the subsolar point.

Methane freezes at −184° centigrade, but Jupiter's average temperature is about 60 degrees higher than this; methane is therefore gaseous throughout the atmosphere of Jupiter, at least above the clouds. But ammonia freezes at −78° centigrade, and will be frozen into solid crystals that form the planet's clouds. Whatever NH_3 there is in gaseous form must have sublimated from the solid crystals in the clouds.

Now, the partial pressure of a gas that is in equilibrium with its solid phase depends only upon the temperature. It does not depend upon the elevation of the surface or, as in Jupiter, of the cloud layer. We can roughly estimate this pressure. The total absorption of NH_3 in Jupiter's atmosphere is equivalent to that of a laboratory absorption tube seven meters in length (0.007 kilometer), filled with ammonia and kept at normal atmospheric pressure (760 millimeters) and at a temperature of 300° absolute.

The earth's atmosphere, if of uniform density, would extend to a height of about eight kilometers. Thus, the ratio in these two heights is 8/0.007, or 1,100, and the NH_3, on the earth, would account for a pressure of the order of 0.7 millimeter of mercury. On Jupiter, the higher surface gravity would increase this partial pressure to 1.8 millimeters. The saturation vapor pressure of ammonia is 3.78 millimeters at −100° centigrade, and 0.00056 at −150°, as given by Kuiper. The pressure of 1.8 millimeters corresponds well enough to the values of −123° (150° absolute) adopted by Hess from more precise considerations, which took into account the variation of NH_3 absorption over the disk of the planet.

The temperature decreases toward the poles by about six degrees between the equator and latitude ±60°. Hess writes, "This is understandable in terms of the large diurnal variation in the height of the upper cloud surface at the equator. This variation suggests that much of the solar heat received goes toward sublimation of ammonia crystals rather than toward an increase in temperature. The more rapid sublimation at the equator keeps the temperature low and decreases the pole-to-equator temperature gradient."

The morning limb is cooler than the evening limb, by about four or five degrees, as we would expect, and the evening limb is only slightly cooler than the subsolar point.

We know little about the total amount of atmosphere on Jupiter. Its extent, above the cloud level, has been estimated by Peek to be about 200 kilometers. If this means that the density at this level is similar to the density in our own atmosphere at about 50 kilometers, the ratio would be four in total amount, and also about four in pressure at the surface of the earth and the cloud level of Jupiter. But the uncertainty is great. In the revised edition of *The Atmospheres of the Earth and Planets* (University of Chicago Press, 1952, page 380), Kuiper gives total pressures at the cloud level of 24 atmospheres and two atmospheres, depending upon which of two assumptions he uses regarding the abundance ratio of hydrogen plus helium to methane.

We know next to nothing about the extent of Jupiter's atmosphere below the cloud level. Peek has estimated that its thickness cannot exceed 25 kilometers, because the pressure would then become so great that even H_2 would be compressed to a near-solid state. And Kuiper has remarked that this compression would put the material above its critical point, so that there would be no distinction between the gaseous and liquid states. According to Peek and Kuiper, the red spot on Jupiter may be a solid island floating in this liquid-gaseous medium, covered by a cap of clouds in which Wildt's chemical reactions of sodium and ammonia account for the red color.

Since in Saturn practically all ammonia is frozen out, Hess has observed only its methane bands. Here the absorption intensities *increase* with the latitude, the contrary of what was found on Jupiter. The observed variation can be explained partly, but still not completely, by the increased path length at the higher latitudes. The cloud level may be a few kilometers higher at ±50° than near the equator. The effect is smaller than on Jupiter, perhaps because there is less active sublimation of the NH_3 clouds near the subsolar point.

LETTERS

Sir:

The two articles on the aurora in your December, 1953, issue underline the value of visual observations, but the accompanying charts of auroral frequency may lead amateurs living south of the Canada-United States border to believe that an observing program can have only a very small yield.

At the Portage Lake Observatory of the University of Michigan, located 15 miles northwest of Ann Arbor, it has been the custom since June, 1951, to record the occurrence of the aurora borealis on each observing night. Although we have an excellent northern horizon, with no interference by city lights or smoke, it should be emphasized that we are not trained **visual** observers, and are ourselves amateurs in auroral study. Any competent amateur could, in fact, improve on our records by including auroral types, angular dimensions, and the like.

The points I wish to make are: that on clear, moonless nights the aurora may be seen more frequently in our part of the world than Vestine's data suggest; and that a number of your readers may find it worthwhile to undertake auroral programs of a more detailed nature than we have found possible in view of the overriding importance of our astronomical work. The clear appearance of the sunspot and annual cycles in our observations, described briefly below, shows that in a relatively short time span, a careful series of auroral records is a contribution comparable to that of observations of a long-period variable over a similar period.

Our own observations are limited to a brief visual search for characteristic auroral arches and streamers; the former manifestation is observed more frequently, and is easily recognized after a little experience. The brighter, lower edge is often only about 10 degrees above the horizon, which thus should be as clear of obstructions as possible. Irregular, cloud-like auroras can be distinguished from true clouds by checking visibility of stars with binoculars.

As pointed out by Chapman and Stibbs, auroral frequency depends on the phase of the sunspot cycle. If we divide our observations into three 10-month intervals, compute the percentages of clear, moonless nights on which auroras were seen, and compare these with the Mount Wilson daily sunspot group numbers averaged over the same months, we find:

July 1951 - Apr. 1952	30%	3.9 groups
May 1952 - Feb. 1953	21%	2.7 groups
Mar. 1953 - Dec. 1953	16%	1.3 groups

Although the final period is very close to sunspot minimum, we observed auroras on 16 per cent of the clear, moonless nights, whereas Vestine's chart on page 36 of the December issue indicates an expectation of about five per cent. Some care is required in translating these percentages into numbers of nights on which auroras may be seen. The chart on page 42 in the article by Kimball appears to be based on the assumption of 243 "suitable" nights annually. On the other hand, we have excluded those clear nights when the moon was within a few days of full. On such nights, the moon being above the horizon throughout, the sky is too bright to permit detection of faint auroras. Over the 30-month period of our observations, there were 307 nights we considered "clear and moonless," and auroras were seen on 69.

Apart from dependence on the sunspot cycle, it is known that auroral activity is strongest at the time of the equinoxes. Dividing our 1952 and 1953 data into those for the eight months, March-April and September-October, and those for the remaining 16 months, the "auroral nights" occur 24 per cent of the time in the equinoctial periods and 18 per cent in the intermediate months.

FREEMAN D. MILLER
University of Michigan Observatory

OPTICAL SOCIETY MEETING

The Optical Society of America will hold its fall meeting in Los Angeles, Calif., at the Ambassador Hotel, on October 14-16. The sessions are open to all interested persons. A society trip to Mount Palomar is scheduled for October 18th.

NEWS NOTES

By Dorrit Hoffleit

RELATIVITY RED SHIFT VERIFIED

From data obtained over a period of three years at Mount Wilson Observatory, Dr. Daniel M. Popper, of the University of California at Los Angeles, has succeeded in verifying a hitherto incompletely checked test of Einstein's general theory of relativity. The prediction is that a process taking place near a large mass will appear to proceed at a slower rate than if the mass were absent.

As a result, the lines in spectra of stars with unusually high surface gravity, such as white dwarfs, should show a noticeable red shift. The star must also be a member of a binary system, in order that the effect sought may be separated from other red shifts caused by motions of the star. As explained by Dr. Otto Struve in his May article on red shifts in stellar spectra, previous attempts to verify the Einstein prediction, using the white-dwarf companion of Sirius, have proven inconclusive. Observations of Sirius B are difficult because of the overwhelming brightness of the primary star.

Dr. Popper found that the 9th-magnitude white dwarf 40 Eridani B was more suitable for the test. It is a member of a binary system with a period of 250 years, and it is well separated from the primary star; the latter is also not too much brighter than the white dwarf and its light does not interfere. From 37 spectrograms, he measured the red shift as 21 ±2 kilometers per second, in satisfactory agreement with the predicted 17 ±3 for this star. The probable errors are internal, however, and realistic estimates of the uncertainties would make them considerably larger, according to Dr. Popper.

FLARE STARS

Late in 1952, Sarah Lee Lippincott, Sproul Observatory, compiled a list of eight known and 38 potential flare stars (see *Journal*, Royal Astronomical Society of Canada, January-February, 1953). Normally faint, these *M*-type dwarf stars undergo sudden erratic increases in brightness amounting to as much as six magnitudes. A flare may last from a few minutes to nearly an hour. The spectra of known flare stars show emission lines of ionized calcium; the potential flare stars have similar spectra and faint absolute magnitudes.

More recently, Z. Svestka, of Czechoslovakia's Ondrejov Astrophysical Observatory, published a similar list of 50 known and promising flare stars. Each list contains some stars not in the other. Both investigators believe that the amplitude of a flare star depends inversely on its real brightness. A star normally of visual absolute magnitude +17 may flare by three magnitudes, whereas one normally +10 will brighten by only 0.1 magnitude. Hence, search for flares among intrinsically bright red dwarfs should prove futile.

Ten red dwarf stars with emission spectra and of absolute magnitude 14.5 or fainter are known; these may have flares with amplitudes in excess of two magnitudes. Among them, Proxima Centauri and L726-8B are already known to flare; five others with apparent visual magnitudes +13.5 or brighter are listed here. A search for flares, by amateurs as well as professionals, should prove rewarding.

Star	*R.A.* (1950) h m	*Dec.* (1950) ° ′	*Spectrum*	*Magnitude App.*	*Abs.*
L726-8A	1 36.4	−18 13	d*M*6e	12.5	15.6
Wolf 359	10 54.2	+ 7 20	d*M*6e	13.5	16.6
Ross 845	14 10.5	−11 47	d*M*5.5e	13.5	14.7
L789-6	22 35.7	−15 37	d*M*5.5e	12.3	14.5
Ross 248	23 39.4	+43 55	d*M*5.5e	12.2	14.7

POWER FROM THE SUN

Conversion of solar energy into electric current for everyday use is now nearly on a practical basis. In April, the Bell Telephone Laboratories demonstrated a silicon cell similar in principle to the germanium transistor. More recently, the Wright Air Development Center, Dayton, Ohio, announced a solar battery made of crystals of cadmium sulfide, a material used as a yellow pigment in paints.

In the Bell development, a razor-thin strip of silicon, containing arsenic, is used. This is treated with a gas containing boron, which diffuses into the silicon to a depth of less than 1/10,000 inch. When sunlight falls on the strip, the whole surface becomes a source of current, one square yard producing about 50 watts of power at 0.3 volt. The efficiency is about six per cent.

The Air Force battery is even more efficient—a wafer-thin slab four by 15 feet should be able to supply enough current to operate all electrical appliances in an average household for 24 hours a day.

IN THE CURRENT JOURNALS

THE NATURE OF THE UPPER ATMOSPHERE, by H. S. W. Massey, **Endeavour,** April, 1954. "Some of the most important effects of the atmosphere which make life possible on the Earth's surface are located at very high levels."

LAPLACE, by James R. Newman, **Scientific American,** June, 1954. "Historians of science have rightly called the Marquis de Laplace the Newton of France. He earned the title for his immense work on celestial mechanics. . . . He was a man of curiously mixed qualities: ambitious but not unamiable, brilliant but not above stealing ideas shamelessly from others, supple enough to be by turns a republican and a royalist in the tempestuous time in which he lived — the era of the French Revolution."

MARS: 1954, by E. C. Slipher and A. G. Wilson, **Leaflet** No. 301, Astronomical Society of the Pacific, June, 1954. "Though an ultimate objective is to settle definitively the question of the existence or non-existence of life on Mars, the immediate problems concerning observers of the planet this summer are in the field of 'areophysics' as the 'geophysics' of Mars is properly called."

SCINTILLATION VERSUS IMAGE MOTION

Astronomical seeing is usually analyzed in three components: scintillation (twinkling or fluctuation in brightness), image shape, and image motion. At the McMillin Observatory, Ohio State University, Roger Hosfeld has found that scintillation and image motion occur independently. He made photoelectric studies to measure brightness changes and took trailed Hartmann images to test image motion. He found, for example, that one evening Arcturus showed much more scintillation than on the next day. On the basis of image motion, however, seeing was better on the first occasion.

He then turned to double stars, finding that their components appeared to move together but scintillated independently. Observing first under normal conditions and again after introducing warm air into the dome of the 12½-inch McMillin refractor, Mr. Hosfeld ascertained that total brightness of an image was not affected even by temperature differences sufficiently severe to accentuate image motion and destroy telescopic definition.

Thus, these two factors of seeing are essentially independent. Scintillation appears to be caused by atmospheric turbulence at greater heights than that causing image motion. If it is definitely unaffected by surface conditions, scintillation may become a useful atmospheric probe.

The details of the investigation are reported in the April *Journal* of the Optical Society of America.

METEOR FLARES

Many meteors during their flight may increase in brightness by one or two magnitudes for a brief interval, usually about 0.1 second. After such a flare, the meteor fades more rapidly and vanishes sooner than is predicted by theories valid for nonflaring meteors. In the March *Astrophysical Journal*, Henry J. Smith, of Harvard's Boyden station, concludes that a meteor flare arises from "the simultaneous emission of several thousand microscopic particles rather than the fracture of the parent body into a few larger pieces." The masses of the individual particles in the spray average about one one-millionth of a gram.

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BOOKS AND THE SKY

THE SUN

Gerard P. Kuiper, editor. University of Chicago Press, Chicago, 1953. 745 pages. $12.50.

TWENTY-THREE solar physicists in six countries have collaborated in writing **The Sun,** the first volume of a projected four-volume work on the entire solar system. The editor gives a particularly beautiful example of how contributions by different authors can be combined into a uniform whole. The individual chapters fit so smoothly together that the effect is of a single book rather than a collection of essays.

The work is a handbook in the best sense. It gives a bird's-eye view, and shows important interrelations. The results of a myriad of single investigations are critically interpreted and collected into a well-rounded report, illustrated by extensive and often new pictorial material. The many references make it always possible for the reader to turn to the original literature. In a few places somewhat more care could have been taken in the compilation. Thus occasionally pictures are reproduced from other works, without the original captions or descriptions from the earlier text, so that the reader cannot fully assimilate these illustrations. Elsewhere the reader finds without explanation the abbreviation AAVSO, which may puzzle the nonspecialist. Yet in general the contributions are clearly written and understandable.

The first eight chapters summarize our knowledge of the sun itself. Here the results of research and the theoretical interpretations are prominent, while the problems of techniques involved in obtaining these results are not discussed in detail. These are taken up together in Chapter 9, which contains contributions by 13 different authors.

Let us briefly consider the individual sections. In the first chapter L. Goldberg gives a very readable account of the history of solar investigation, particularly at Mount Wilson Observatory. This introductory chapter also describes and lists the fundamental astrophysical constants of the sun.

B. Stroemgren in the next chapter, "The Sun as a Star," writes on its internal constitution. Here—as in the other more theoretical parts of the book—the basic equations are given and are clearly explained, but are not mathematically derived in detail. Then the problems are indicated, and the outlines of the calculation of a model sun are systematically presented, again without detailed mathematical derivations. The various solar models previously computed are briefly developed, critically examined, and compared. The interesting problem of nuclear processes in stellar interiors is treated in particular detail.

The next contribution, by M. Minnaert on the photosphere, is similar in character. He offers nothing fundamentally new, but draws a physically clear and coherent picture, without long mathematical developments. A critical scrutiny of all known layers leads to the proposal of a new "compromise model" of the photosphere. The sections on the formation and widths of the Fraunhofer lines and the computation of line profiles are particularly good in giving a clear idea of the processes involved, but problems associated with polarization are dealt with more briefly. This chapter is supplemented by an appendix where sunspot structure and the radiation from sunspots are discussed.

Charlotte Moore Sitterly gives a good general historical account of the identification of lines in the solar spectrum, and associated problems in atomic physics.

Among the most valuable contributions in the book is H. C. van de Hulst's chapter, "The Chromosphere and the Corona." Here not only is our present knowledge collected, but also van de Hulst has attempted, from a critical examination of the data, to give a systematic and in many ways novel picture of the structure of the chromosphere and corona. Naturally, he does not give all the answers, for the transition from the photosphere to the chromosphere, chromospheric structure, and how the high temperature of the corona is maintained are today the focal points of research, and still present many unsolved puzzles. Nevertheless, this discussion contains stimulating new ideas. Probably nowhere else can be found so lucid a statement of the present position of such investigations.

So far the book has dealt with the structure of the normal, undisturbed sun, from its core to the outermost corona. In the sixth chapter, K. O. Kiepenheuer takes up solar activity. Phenomena directly accessible to observation, such as spots, faculae, flares, prominences, corpuscular radiation, and cosmic rays, are described. The subject is covered in considerable detail, with particularly varied illustrations. Parts of it might perhaps have been dealt with more concisely.

J. L. Pawsey and S. F. Smerd then give a brief, clear account of solar radio emission. After a historical survey of this youngest branch of solar research, the theoretical data are presented, and observations of the various components of the radiation are described and discussed. The still very vague subject of the mechanism (plasma oscillations) which produces solar radio emission is briefly considered.

More theoretical is the next chapter on solar electrodynamics by T. G. Cowling. After presenting the basic equations, he interprets from the viewpoint of hydrodynamics and electrodynamics such questions as solar rotation, the origin of solar magnetic fields, spot formation, the sunspot cycle, and flare phenomena. Today there is much work being done in just this subject of the interaction of matter with magnetic and electric fields on the sun, and it is particularly welcome to have a readable and critical survey of the most important theories and investigations.

The observational side comes to the fore in the very complete last chapter already mentioned, where specialists report

on techniques and instruments. Only a few items can be mentioned here. G. Van Biesbroeck's photographs of the corona form a beautiful supplement to the earlier chapter on solar activity. R. R. McMath's contribution on the construction of tower telescopes provides many interesting practical details; however, his treatment limits itself rather one-sidedly to the McMath-Hulbert Observatory. In the following sections, J. W. Evans writes on interference filters and coronagraphs; R. Tousey, on methods and results of solar observations with rockets; and J. P. Wild, on the techniques of measuring radio noise from the sun. There are also discussions of Babcock's magnetograph, questions of solar patrol, eclipse problems, and much else.

At the close of the book there are two very useful tables, which list optical and radio instruments at all important solar observatories.

The solar physicist will welcome this book heartily, for it gives him co-ordinated synopses of the present state of the individual problems. No longer is it possible for the solar physicist to be a specialist in every aspect of his subject. Yet he must have some acquaintance with all its branches, for they all interlock, and there is scarcely any problem in solar research that can be dealt with by itself. Thus the book provides valuable help. Scientists in other fields will find pleasure and profit in it, if they wish to orient themselves concerning our sun.

Apart from mathematical and technical details, the very informative and often almost narrative style of **The Sun** should make it easily readable by a wider circle. It gives a broad picture of today's situation in solar research that the nonspecialist could never draw from the scattered original literature.

The remaining volumes of this work are eagerly awaited, for there has been no systematic and complete report on the entire solar system since Volume 4 of the **Handbuch der Astrophysik** in 1929.

P. TEN BRUGGENCATE
University Observatory
Goettingen, Germany

SCIENCE IN PROGRESS

G. A. Baitsell, editor. Yale University Press, New Haven, 1953. 285 pages. $6.00.

THIS book is the eighth of a series of biennial publications based on the national Sigma Xi lectures. It consists of 10 contributions by experts in as many different fields, summarizing recent research in their specialties. The selections are mainly from the biological sciences and astronomy. This reviewer had hoped to find the physical and earth sciences represented more fully.

Many people would hardly call this a book for bedtime leisure reading. It is meant for those who already have some scientific background and want up-to-date information on a variety of topics.

For instance, one can get the gist of G. Gamow's views on the origin and evolution of the universe in a single chapter, without having to read everything he has written on the subject. He describes his idea that the universe had a definite beginning in time, and that all matter began as a compressed, homogeneous nuclear stew that he calls ylem. According to Gamow, the chemical elements formed from this stew perhaps half an hour after the expansion of the universe began. After 30 million years the expansion resulted in a breaking up of the mass, from which successive condensations produced the stars, planets, and satellites, all by a uniform process. Gamow looks into the future to predict final explosions of the stars as their hydrogen fuel is used up. When asked, "What existed before the ylem?" he uses St. Augustine's reply to the question, "What was God doing before He made Heaven and Earth?" "He was making Hell," wrote St. Augustine, "for persons who ask that kind of question."

Other chapters of particular interest to the astronomical reader are W. O. Roberts' discussion of the sun's atmosphere, and J. Kaplan's on the terrestrial atmosphere. Additional sections deal with microwave spectroscopy, the history and evolution of insects, the origin of man, the orientation of animals, biological co-operation, and luminescent organisms, among other topics. Each chapter gives much fundamental information on a very simple level before going into a discussion of the conclusions from recent research.

The writing in **Science in Progress** ranges from interesting and lucid to dull and pedantic. How a reader reacts will depend to some degree upon his motive for reading and his personal interest. It is a fine source book, and as such should not be judged by the usual journalistic standards. Yet one can hardly refrain

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from wishing that some scientists would remember their readers when they are writing, and strive for a lighter touch which need not lessen technical accuracy.

All through the book, however, the authors and editors have made a definite effort to relate the research to practical life. This makes the book functionally useful for science teachers and for laymen who want to know how science enters into their everyday lives.

JOHN STERNIG
Assistant Superintendent
of Schools
Glencoe, Ill.

ASTRONOMICAL PHOTOELECTRIC PHOTOMETRY

Frank Bradshaw Wood, editor. American Association for the Advancement of Science, Washington, D. C., 1953. 141 pages. $3.75.

MOST **Sky and Telescope** readers are well aware of the remarkable impetus given to observational astronomy by postwar applications of electronics to the measurement of light. Developments such as the multiplier phototube and the stable linear amplifier have largely changed photoelectric photometry from a delicate, semilaboratory method to a relatively simple and rugged research tool.

With any such rapidly growing field, there is a great need for critical, summary literature. There is no "ATM" of photoelectric photometry available on either the amateur or professional level. The rapid dating of circuits, components, and techniques would soon make such a work out of date. One solution of the problem is the symposium, at which a few active workers report on their own specialties. **Astronomical Photoelectric Photometry** is the record of such a symposium, held at Philadelphia in December, 1952, on photoelectric instrumentation and technique.

Even within this limited field there was little consideration of mechanical or optical design factors, or of photosensitive devices. Most of the discussion centered around the present competition between the four basic methods of translating the photoelectric signal into usable form: AC and DC amplification, null methods, and pulse counting. Each of these is represented by a chapter in the present volume.

A. P. Linnell, after a brief introduction to the general problems and literature of photoelectric photometry, discusses DC amplifiers, emphasizing stability and linearity considerations. The massive list of references following this chapter covers most of the important papers of the last 30 years on photoelectric photometry, and will be extremely valuable to anyone contemplating serious research in photometer design or applications.

Several types and uses of AC amplifiers are sketched by J. S. Hall. These include an interesting multipurpose photometer which registers polarization, magnitude, and color simultaneously. Of great use to the average photoelectric worker is Hall's comprehensive practical treatment of sources of error under actual observing conditions.

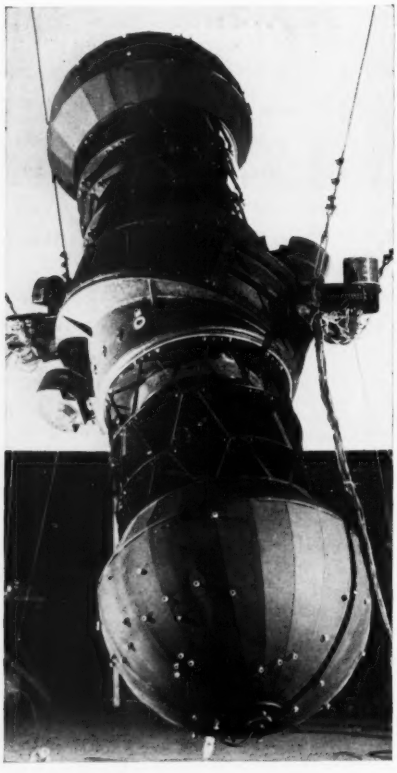
Pulse-counting instruments are dealt with at some length — the Cook-Flower-Princeton ones by W. Blitzstein, and the Cambridge, England, ones by R. Redman and G. Yates. The many details given are welcome, since pulse-counting techniques are new and unfamiliar to most photoelectricians. Observers in the eastern United States will be encouraged that some useful photoelectric sequence work can be done even in a British climate.

Th. Walraven suggests one solution for climatic problems, as well as simplification of reductions, by his comparison photometer, designed for simultaneous measurement of a variable and its comparison star. The instrument has a limited function, but fulfills this so well as to suggest that others of the kind will probably be constructed.

An excellent summarizing paper by A. E. Whitford discusses limits of the various techniques in a manner somewhat different from that of Hall, and compares critically the methods now in use.

As the editor points out in the preface, there is actually little reason to believe that one of the procedures mentioned here will prove superior in all applications. There is a growing consensus that null methods are fine for special purposes, that AC and DC techniques in practice are essentially equivalent, although the latter has a small theoretical advantage, and that pulse counting seems the logical method for work near the limit of faintness with any given telescope.

This volume should not be obtained in hopes of finding a construction manual for photometers, although some useful suggestions are given. The lack of an index is unfortunate. By reading this book, one



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HARLAN J. SMITH
Yale University Observatory

HIGH-ALTITUDE ROCKET RESEARCH

Homer E. Newell, Jr., Academic Press, New York, 1953. 298 pages. $7.50.

IN man's continuing effort to conquer nature, the development of the German V-2 rocket represents an enormous stride forward. Fortunately, the V-2 turned out to be less important as a weapon of war than as an instrument of scientific research. Before 1946, deduction and indirect observation provided our only knowledge of the high atmosphere above 25 miles, and of solar radiation in the spectral regions where our atmosphere is opaque. When the U. S. Army Ordnance "liberated" V-2 rockets and brought them to the White Sands Proving Ground in New Mexico, they opened up a new area of scientific research. For the first time critical measuring equipment could be sent to altitudes of 100 kilometers or higher. Entirely new techniques of physical measurement, involving remote control and remote registering, were developed for this new kind of scientific enterprise. We are still in the early stages of this type of research, and no one dares to predict a limit to its extent or its impact on our science and on our culture.

High-Altitude Rocket Research is the scientific story of this subject to date. Dr. Homer Newell, of the Naval Research Laboratory, has been in the heart of this scientific research almost since its inception and, after a year or two, took charge of the laboratory's program. No one is better qualified than he to describe the rocket research program from the viewpoints both of technology and of basic science. It was not easy to strike a proper balance between the technological aspects, scientific results, and a popular description for the benefit of the host of general readers interested in this romantic scientific development. Dr. Newell's success with all three aspects is indeed a tribute to his versatility.

While this is not a popular-type book, the educated layman will find much interesting and understandable material in it. With a little patience and some skipping he can gain a broad understanding of modern rockets and their scientific uses.

To the scientist, **High-Altitude Rocket Research** presents a clear-cut though not elaborate statement of methods, theory, and results, whose value is enhanced by extensive references and good indexing.

Dr. Newell's opening chapter briefly summarizes the upper atmosphere as we know it today, and gives a complete list of scientific rocket firings. Then he provides considerable practical information concerning the rocket vehicles themselves, the German V-2, our WAC Corporal rocket, Aerojet's Aerobee, and the Navy's Viking rocket. In connection with the problem of recovery of data from rockets, Dr. Newell gives a good description of the telemetering systems which read instruments at high altitudes and send radio signals back to the ground receiving stations.

Next the author addresses himself to the results obtained from rocket firings: measurements of air pressures, densities, temperatures, and chemical composition at great heights, and winds in the upper atmosphere. Perhaps the chapter of greatest importance to astronomers is the discussion of rocket studies of solar radiation, particularly in the far ultraviolet and X-ray regions of the spectrum.

Two additional chapters summarize investigations made by rocket techniques of the ionosphere, the earth's magnetic field, and cosmic rays. Lastly, the methods of high-altitude photography are considered.

High-Altitude Rocket Research will be a very rewarding and satisfying volume to anyone with a genuine interest in the scientific aspects of the investigation of our atmosphere by rockets. Probably it will become a classic in this new field of research, which I hope will be a stepping-stone to full-scale scientific research either from a satellite station or in deep space itself.

FRED L. WHIPPLE
Harvard College Observatory

THE TRUE BOOK ABOUT THE STARS

H. P. Wilkins. Frederick Muller Ltd., Earl's Court Gardens, London S. W. 5, 1954. 135 pages. 6s.

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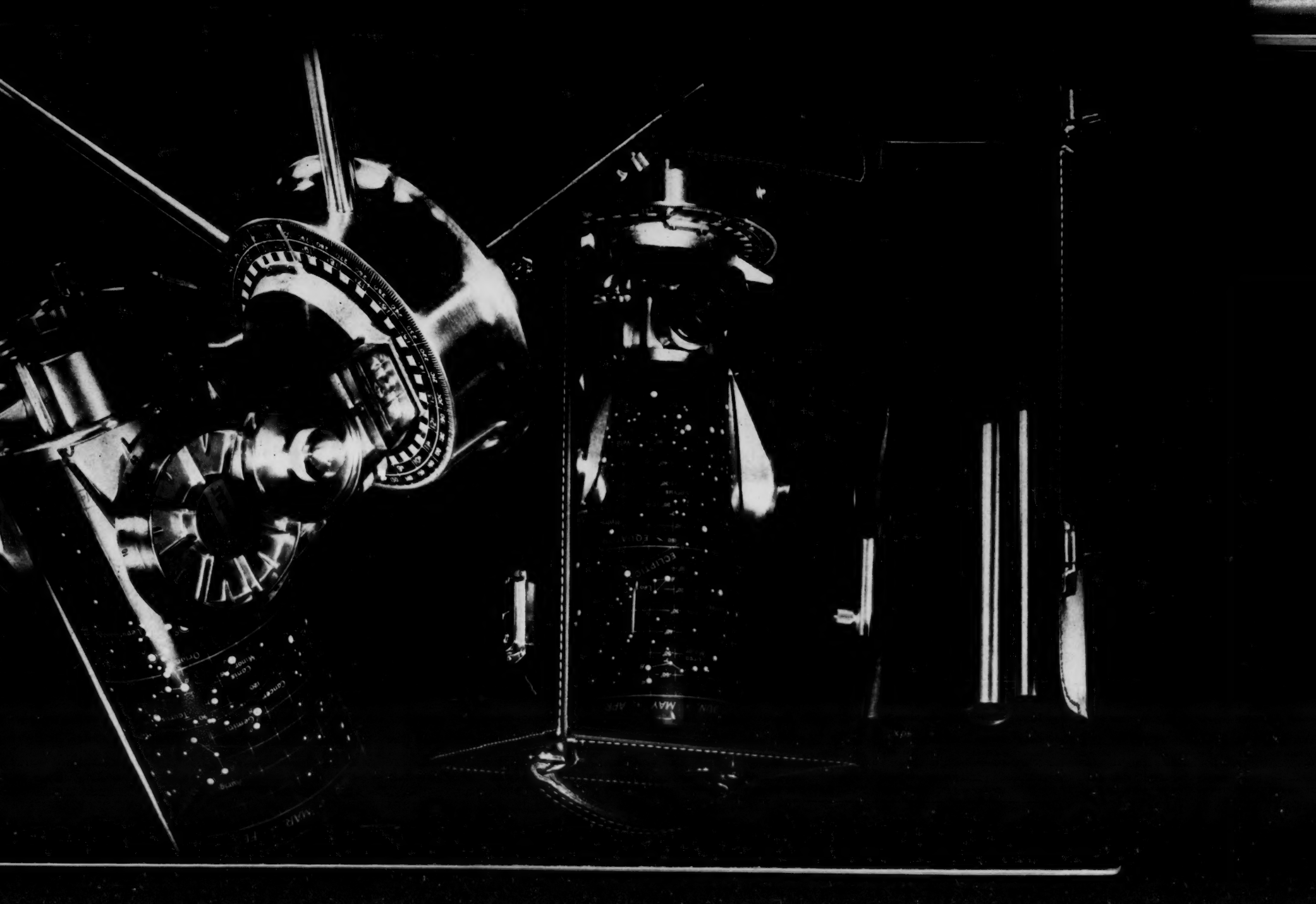

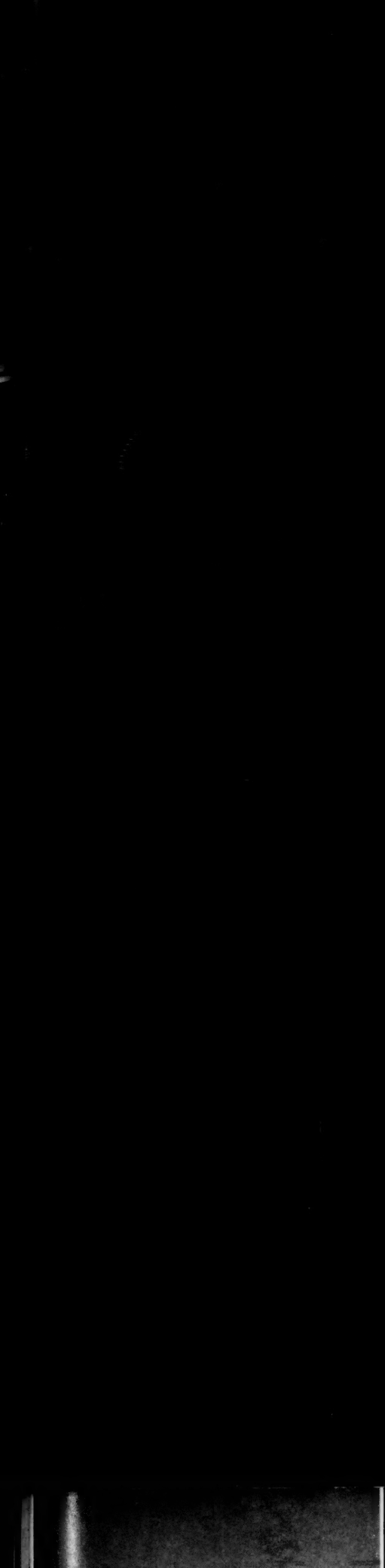

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chapter gives directions for making such a telescope, but they are so brief that some help from a grown-up may be needed.

The most striking thing about this book is the wealth of factual information it holds, despite its small size. Even topics like the history of Jupiter's great red spot and the light changes of the novalike star Eta Carinae are traced. The accuracy of the facts upholds Dr. Wilkins' reputation as one of the most outstanding British amateur astronomers. His few sins are venial, such as his brief speculation on the fauna and flora of the planet Venus, and there are a few places where he strays above or below the teen-age level.

The very low price of the book has probably ruled out photographs as illustrations, but there are pen drawings, many by the author. A few of these seem rather coarse and harsh, as for example the pen sketch of Saturn (not by the author); it may be well to have these redrawn for the next edition.

This is the best book of its class that I have seen, and it can be widely recommended for young people.

MARTHA D. ASHBROOK
Weston, Mass.

NEW BOOKS RECEIVED

ESSAYS IN SCIENCE, *Albert Einstein*, undated, *Philosophical Library*. 114 pages. $2.75.

Einstein's *The World as I See It* was a collection of popular essays first published in 1933, which is now abridged by the omission of political and sociological items. The 16 essays here reprinted deal with topics such as Kepler's place in astronomy, the origin of the theory of relativity, and the cause of meanders in rivers.

THE NATURE OF LIGHT AND COLOUR IN THE OPEN AIR, *M. Minnaert*, 1954, *Dover Publications*. 362 pages. $3.95 cloth, $1.95 paper.

A well-known Dutch astronomer gives an extended popular account of many natural phenomena of interest to the amateur astronomer, including rainbows, halos, and coronas; the light and color of the sky, and twilight phenomena; color vision, after-images, and contrast effects; the zodiacal light, and star colors. This is an unabridged republication of the scarce 1940 translation.

CONCERNING THE NATURE OF THINGS, *Sir William Bragg*, 1954, *Dover Publications*. 232 pages. $2.75 cloth, $1.25 paper.

In this reprint of a book that first appeared in 1925, the author explains to the general reader the atomic structure of matter, and the nature of gases, liquids, and crystals. This leads to such byways as what happens when a golf ball is sliced, the shapes of snowflakes, and how Damascus sword blades are made.

GEORGE DAVIDSON: PIONEER WEST COAST SCIENTIST, *Oscar Lewis*, 1954, *University of California Press*. 146 pages. $3.50.

This is the first extended biography of George Davidson (1825-1911), an active astronomical observer who was associated with the origin of the Lick Observatory, and who played an important part in stimulating interest in science in California. There are as appendices a chronology of Davidson's career and a list of his writings.

PHYSICAL METEOROLOGY, *John C. Johnson*, 1954, *Technology Press* and *Wiley*. 393 pages. $7.50.

Intended primarily as a textbook for graduate students in meteorology, *Physical Meteorology* covers those phenomena of our atmosphere not directly linked to its circulation. There are detailed discussions of meteorological optics and visibility; the thermal properties of the atmosphere; applications of radar to meteorology; precipitation; and the upper atmosphere. Extensive lists of references are provided.

OUR MOON, *H. Percy Wilkins*, 1954, *Frederick Muller Ltd.*, 110 Fleet St., London E. C. 4. 180 pages. 12s 6d.

Dr. Wilkins, the well-known British student of the moon, has written a new descriptive account of the surface of our satellite. The appendices include descriptions of individual craters, and a list of reference works about the moon.

PLANETARY TABLES. VOLUME FIRST: TABLES OF MERCURY, *Harihar P. Bhatt*, 1953, *Gujarat Vidya Sabha*, Bhadra, Ahmedabad, India. 55 pages. 2 rupees.

These tables can be used to calculate Mercury's position for any time between 1200 B.C. and A.D. 2400. They are an abridgement of Newcomb's tables of Mercury, and afford an accuracy of about three seconds of arc in the geocentric longitude. Similar tables for the other planets are planned.

The explanation of the tables of Mercury is not very clear, and may cause difficulties for persons with limited experience. If an accuracy of only one degree is needed, it would be much more convenient to use Neugebauer's "Approximate Tables for Sun and Planets," *Astronomische Nachrichten, 248*, 161, 1933.

TIME COUNTS, *Harold Watkins*, 1954, *Philosophical Library*. 274 pages. $4.75.

The calendar and calendar reform are the subject of this book. There is a historical account of how the Gregorian calendar was adopted, and of the many simplified calendars proposed as substitutes.

THE PRINCIPLES OF PHYSICAL OPTICS, *Ernst Mach*, 1953, *Dover Publications*. 324 pages. $3.50 cloth, $1.75 paper.

This is a reprint of the 1926 translation by J. S. Anderson and A. F. A. Young of a classic work written in 1913. It is a historical treatment of such topics as refraction, the wave nature of light, interference, and polarization, mainly from the experimental viewpoint. Mach's insight and clarity have given his book permanent value.

THE PERMANENT REVOLUTION IN SCIENCE, *Richard L. Schanck*, 1954, *Philosophical Library*. 112 pages. $3.00.

Intended for those interested in the philosophy of science, this volume analyzes recent trends in the methodology of different sciences. The author is professor of sociology at Bethany College.

MATTER ENERGY MECHANICS, *Jakob Mandelker*, 1954, *Philosophical Library*. 73 pages. $3.75.

The author is associate professor of mechanics at the Georgia Institute of Technology. Mathematical in character, his book examines the consequences of regarding mass, as used in classical mechanics, as not constant, but changing with the energy content of the body in question.

OPTICAL IMAGE EVALUATION, *National Bureau of Standards Circular 526*, 1954, U. S. Government Printing Office, Washington 25, D. C. 289 pages. $2.25.

Intended for the advanced optical designer, this volume reports a 1951 symposium at the Bureau of Standards on the evaluation of optical image-forming systems in terms of physical optics, which is now possible even when the system is only in the design stage. Many new testing methods and computing techniques are described.

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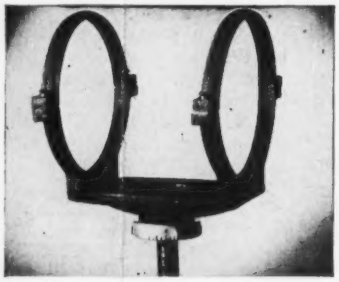

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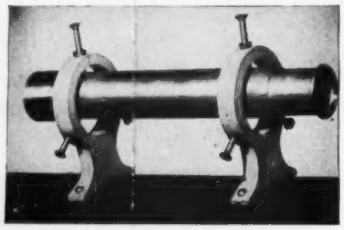

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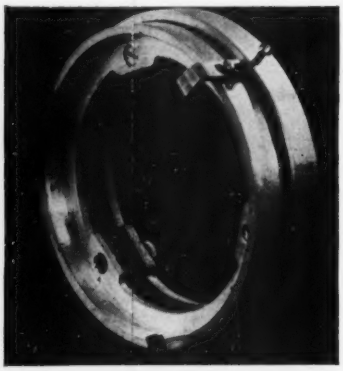

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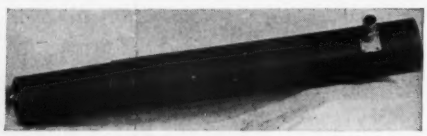

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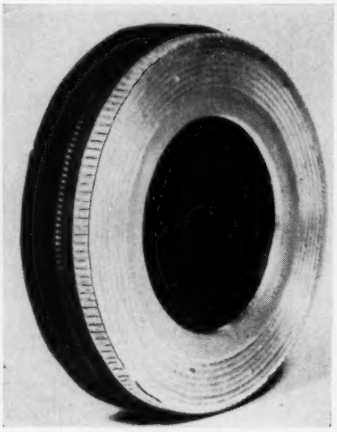

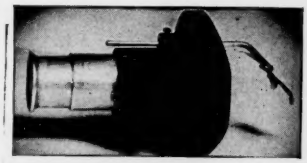

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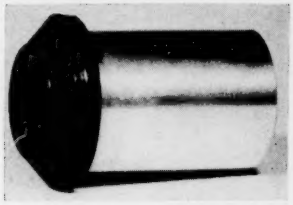

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Field of View and Image Size

AMATEURS are often faced with the problem of determining the field of view of a camera or a telescope used for photography, as well as the image size of the moon, planet, or other object of which a photograph is to be taken. This information is essential when planning to record occultations or close conjunctions of the moon and bright planets, or to take prime-focus pictures of clusters and nebulae. With modern films and fine-grain developing, small-scale images are worth taking, as with careful enlarging these may make very fine pictures.

The mathematical expression for finding the angular field of an instrument is merely a rearrangement of that for image size. The formula is **V = SC/F**, where **V** is the angular field, **S** is the film size (width of photosensitive surface), **C** is a constant, and **F** is the focal length of the telescope in inches. For **V** to come out in degrees, **C** is 57.3; for minutes of arc it is 3,438; and for seconds of arc, 206,265.

Let us consider an amateur telescope to which is attached a camera case for 35-mm. film, the picture to be taken in the focal plane and not projected through an eyepiece. As a simple example, suppose the focal length to be 57.3 inches, the size of the film one inch, and **C** to be 57.3. Then **V** comes out one degree, or just about two moon diameters. Were the focal length 75 inches, **V** would be 0.764 degree, or 45.84 minutes of arc. To avoid converting from degrees to minutes, use 3,438 for **C** and express the answer in minutes of arc whenever the focal length is longer than 57.3 inches.

Another important use of the formula is to find the field of a hand camera or a portrait lens adapted for photography of the heavens. A common question might be, "I have a press camera that takes a 4-by-5 film and has a lens of six inches focal length. What is the field covered along the 5-inch length?"

The formula gives $5 \times 57.3/6$, or 47.75 degrees. Along the 4-inch length of the film, the field is 38.2 degrees, and the reader might check this to familiarize himself with the formula. However, few of the lenses the amateur finds in his camera today will cover areas this large with good star images. Astronomical photography imposes much stricter demands on image quality at the edges of a field than does terrestrial photography.

Another example, for the world's largest telescope, may be useful. The focal length of the 200-inch mirror is 660 inches, and when the observer rides the cage at the upper end of the tube his plate size at the prime focus is 5 by 7 inches. We use 3,438 for **C**, to find that the 5-inch side covers 26.05 minutes of arc, while the 7-inch side extends 36.46 minutes. The full moon cannot quite fit into the plate size at the prime focus of the Hale telescope.

The problem of image size probably concerns the amateur more frequently. If we solve our original equation for **S**, we obtain: **S = VF/C**, with the symbols having the same definitions as previously given. Again, the constant should refer to the same units as those of the angular field.

When photographing celestial phenomena with a hand camera, we can now determine beforehand how far apart our images on the film will be. For example, on September 30th, the moon will pass geocentrically 1¼ degrees north of the planet Venus, then near its greatest brilliancy. Seen from the Northern Hemisphere, the distance separating the second and third brightest objects in the sky will be less than a degree (details will be given on the Observer's Page in September). Let us assume the distance between centers to be one degree, and that we have two cameras, one a miniature with a focal length of two inches (51 mm.), and the other with a focal length of six inches. For the first, $S = 1 \times 2/57.3 = 0.035$ inch; for the second, $S = 1 \times 6/57.3$ or 0.105 inch, which clearly illustrates the advantages of longer focal length for astronomical photographs of this kind.

In some instances the images may be so close together on the film that the spreading of light in the emulsion will blot out the picture. Where conjunctions are of the order of a few minutes of arc, ordinary cameras will not separate the images and a telescope of long focal length should be used. Even then, a telescope of over 50 inches focal length would be needed to give two minutes of arc a separation of 1/32 inch in the focal plane.

Consider the critical problem of the separation of double stars at the limit of resolution of a given telescope. In an f/8, 6-inch instrument, the Dawes limit is about 0".75. Our formula shows that one second of arc at this focal length will measure 0.00023 inch in the focal plane; ¾ of this is only 0.00017 inch. The smallness of this amount well illustrates why the mirror has to be almost perfect, the high-power eyepiece of the best quality, and atmospheric seeing excellent if so small a separation is to be

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made visible. The writer has seen two stars one second apart split with a 6-inch reflector and a power around 360 times. The optical combination was a Barlow lens and a medium-power eyepiece giving approximately 1/6-inch effective focal length.

Planetary image size is of special interest to the amateur observer, particularly the size of Mars at this opposition and in 1956. On July 2nd, Mars had a diameter of 21".88, and in a telescope of 48 inches focal length an image size of 0.0051 inch, in the focal plane. This image could be viewed with a high-power eyepiece and enlarged to show, with good atmospheric conditions, many of the planet's most prominent markings.

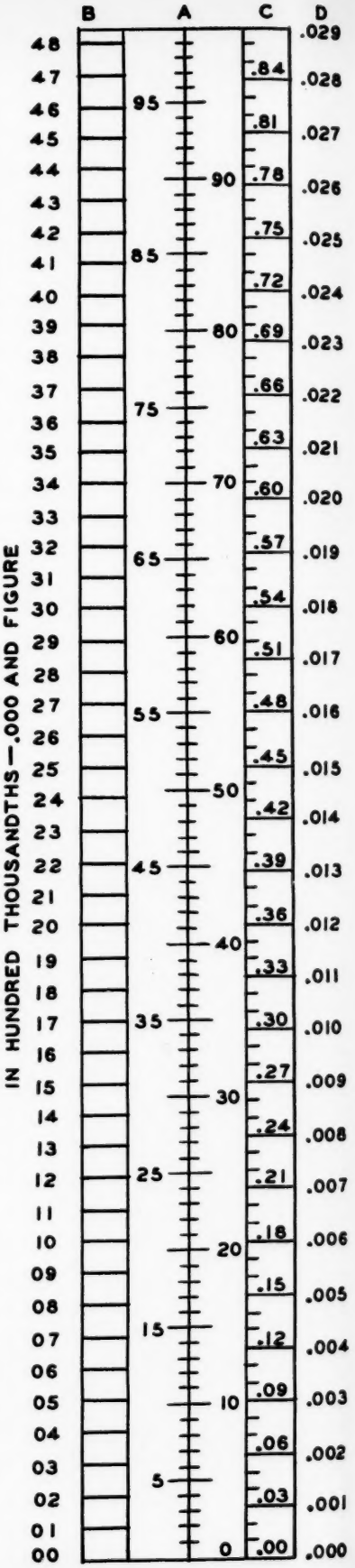
At the f/30 coude focus of the 200-inch telescope, the image size of Mars early in July was over 0.6 inch, quite suitable for rapid lapse-time photographs on 35-mm. motion picture film.

One of the first objects for the amateur trying his hand at astronomical photography is the moon. There are several rule of thumb methods for determining beforehand how large an image is to be expected. A rough way is to divide the focal length by 100; more exactly, one divides by 114.6. We can easily check this, assuming the moon's average diameter to be half a degree or 30 minutes of arc. Substituting in the formula, we have $30 \times F/3{,}438$; divided through by 30, this gives $F/114.6$. The moon's size at 30 minutes of arc equals the focal length divided by 114.6. Although it is quicker to divide by 100, the moon would have to subtend over 34 minutes of arc to make this convenient figure give an exact answer. At a very close perigee, the moon's maximum apparent diameter can reach 33'.5, as at the November 10th full moon this year.

For the exact size of the moon on any night, find its semidiameter in the **Ephemeris**, double it, and then apply the formula to obtain image size in the focal plane.

Amateur telescope makers often use the moon's diameter, or 30 minutes of arc, in choosing their diagonal sizes. This provides a compromise; we desire to minimize diffraction effects and the obstruction of light, but also want to avoid loss of light in the field of a low-power eyepiece outside the area of best definition. Except for comet search or a program in which the amateur intends to "sweep the sky" for faint objects, a diagonal figured on an image size of half a degree is sufficient. (Diagonal size is discussed in Chapter VII, **Making Your Own Telescope**, by Allyn J. Thompson.)

For those who prefer to by-pass the arithmetic, and to provide a fast reference for everyone, we have worked out the accompanying chart. Column **A** is the focal length, in inches, of the telescope mirror, refractor objective, or camera lens; **B** is the image size, in inches, in the focal plane for one second of arc; **C** is the image size for 30 minutes of arc, or half a degree (about the moon's diameter); and **D** is the image size for one minute of arc. To simplify column **B**, only the last two numbers of a decimal beginning 0.000 are given. Column **A** goes up to 100 inches; for focal lengths longer than this, divide by an appropriate



number, such as 2 or 3, and multiply the number read from the graph by the same factor to get the final answer.

In entering the chart, find the division representing the focal length, and opposite this, either left or right, depending upon the scale wanted, find the answer. For example, with a focal length of 70 inches, the image size for one second of arc (column **B**) is 0.00034 inch; for one minute of arc (**D**), it is 0.0203 inch; and for 30 minutes of arc (**C**), it is 0.61 inch.

If the object size is given in seconds, perhaps Jupiter with an apparent diameter of 40 seconds, then multiply 0.00034 by 40 to find 0.0136 inch for the planet's size in the focal plane. Mizar and Alcor, 12 minutes apart in the sky, will, again in the 70-inch focal plane, be 0.0203×12, or almost a quarter of an inch apart.

If the focal length is below 10 inches, greater accuracy can be obtained from the chart by using a focal length 10 times as large and then moving the decimal point one place to the left in the answer. For example, for a 6-inch focal length the figure for column **B** is not quite 0.00003, but by looking under 60 inches we estimate it to be 0.0000292 of an inch.

When the field is large, a few multiples of 30 minutes of arc, the figures in column **C** can be increased correspondingly. For instance, we might want to photograph the pointers of the Big Dipper with a lens of 6-inch focal length. The stars' separation is about 5½ degrees, and the 30-minute image size for the lens is 0.052. Multiply this by 11 (the number of half degrees in 5½), and the result is 0.57 inch.

From the foregoing example, notice that it should be possible to obtain the focal length of a telescope or lens by measuring the size of an object of known angular dimensions in the focal plane. All that is necessary is to photograph the sky, including a field in which the separation of two stars is accurately known. In the absence of a clock drive, star trails may be used. If possible, choose a time when these stars will pass across your meridian. After developing the film, with a powerful magnifier and a scale measure the separation. A vernier caliper that reads to thousandths would be very useful for this measurement.

For example, suppose that the images of the pointers of the Dipper are 0.645 inch apart on the photograph. The distance between the two stars in the sky is 5°.375. If we rewrite our formula to find focal length, we have $\mathbf{F = SC/V}$, where **S** is the separation of the images on the film, **C** the constant, here 57.3, and **V** is the known angular separation of the stars. Substituting in this formula gives 6.876 inches for the focal length of the lens. For accurate results, great care is needed in measuring the distance between the images on the negative.

ROBERT E. COX
Optical Laboratory
Boston University

A HOME-MADE SLIT SOURCE

NEEDING a slit source of light for the Ronchi test, while polishing my 8-inch mirror, I was able to make one with materials practically every amateur has readily at hand. From a piece of sheet copper 0.055″ thick, I cut a rectangular base plate for the slit; this plate measures 1″ by 1¼″, and has cut in it a rectangular

N. K. McKinnon's slit source for mirror testing by the Ronchi method is here assembled, with the slit illuminated.

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6010-A	With Meter	10,000	105.00
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Model	Voltage	Current
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F 6005-AI-5H	5000	500 Ma.
F 6005-AI-K	5000	1000 Ma.

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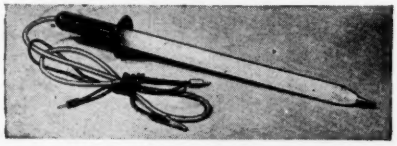

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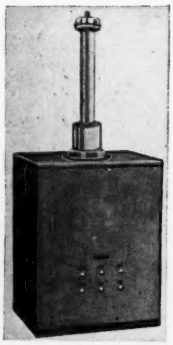

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Model 100 KVT.

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hole 3/16″ wide by 11/16″ long, centered the long way and ¼″ from one end.

A double-edged safety-razor blade was broken in half along the center punching and the broken edges were ground even. These two pieces were placed, with their cutting edges facing, over the rectangular hole in the base plate. Two small strips of sheet metal, 0.005″ thick, were used as spacers to separate the cutting edges of the razor blade sections, which, after being properly centered over the rectangular hole, were soldered in place. The spacers were removed and the resulting slit measured 0.005″ in width by 11/16″ in length.

The sides of the base plate have been thinned along its edges, to fit it to the shield around the light source. The photograph shows the assembly in place on the light source, with the slit illuminated. For the Ronchi test, this slit works well with a 100-line grating, replica or wire mesh, provided the latter is woven like ordinary window screen wire and not twilled.

Shim stock, ordinary thickness gauges, or perhaps paper or tin foil could be used as spacers, the thickness depending on the wishes of the individual. If shim stock is used, when the spacers are cut, the turned edge resulting from the shearing action of the cutter must be dressed off, or the slit jaws may not be parallel. In tinning the sections of the razor blade for soldering, do not let the solder flow over the working edges of the slit, lest their accuracy be impaired.

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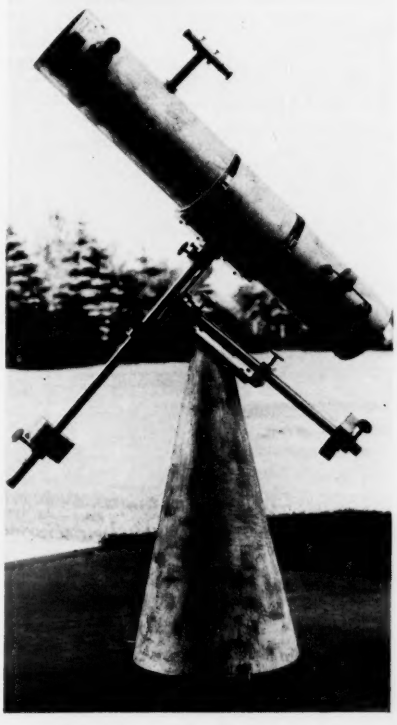
DESIGNED and built by members of the Central Connecticut Amateur Astronomers, a 6-inch reflector was presented to Hillyer College on May 4, 1954, at a ceremony at Van Vleck Observatory, Wesleyan University, Middletown, Conn., the regular meeting place of the group.

The instrument is an f/7, a compromise giving good angle of view, exit pupil, and magnification, as well as portability. The telescope can be quickly disassembled and placed in a car for transportation to suitable observing spots. As might be expected, the seeing in downtown Hartford leaves much to be desired.

The optics are standard, but extreme rigidity has been attained by employing wide spacing between bearings and by the use of the light but stiff conical pedestal. This is made of 20-gauge steel of welded construction and is fitted with internal stiffening rings. There is ample room inside the conical pedestal for a clock drive, should this feature be added in the future. The base of the cone is supported by three studs which are pressed down into the ground when the instrument is used on a grass lawn.

The whole telescope turns in a saddle in accordance with conventional practice, rotating on brass rings shrunk on the main tube. Flanges prevent longitudinal motion, and the fabric straps provide for quick detachment and snug, smooth rotation of the barrel on the walnut bearings of the saddle.

The finish is aluminum lacquer over "ruff-coat" varnish. This, together with the bright brass work and nickel-plate shafts and bearings gives the telescope a very attractive appearance.



Hillyer College's 6-inch reflector.

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VIEW FINDER (Illustrated on the back cover mounted on UNITRON 4″ Photographic Equatorial): 42 mm. (1.6″) coated achromatic air-spaced objective. 10x eyepiece with crosshairs. f/6. Duraluminum tube finished in white enamel. Dewcap. Furnished with mounting brackets with centering screws for collimation. This finder also makes an excellent hand telescope for spectacular wide-field views of the sky. **Only $18.00 postpaid**

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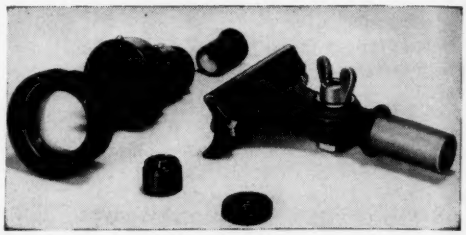

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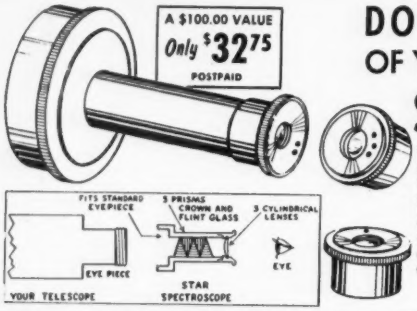

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60° SPECTROMETER PRISM

Polished surfaces flat to ½ wave length. Angle tolerances 5 minutes. Dimensions of polished surfaces 18 mm. x 30 mm. Made from dense flint glass, free of striae and strain.

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Same as above but about 1¼" extension has been added with O.D. of 1¼", which is standard.

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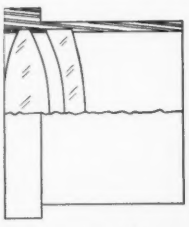

Excellent for collimators or telescope objectives. These top quality objectives were used in the army's $12,000.00 Heightfinder. Made obsolete by radar, they have been subjected to very little use. Color corrected. 64 mms. (2-9/16") in diameter. 18.2" focal length. Perfectly matched pairs.

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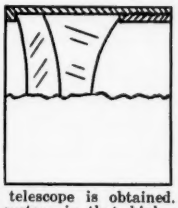
Short Focal Length



E.F.L.: —1.74 ± 0.01 inches
CLEAR APERTURE: 0.96"
O.D. OF CELL: 1-3/16"

A negative achromat called a Barlow lens is used to convert your astronomical objective — lens or mirror — into a telephoto system. Thus a variable-power astronomical telescope is obtained. The great advantage of this system is that higher powers may be obtained without resorting to very short focal length eyepieces or very long and cumbersome telescopes.

Our Barlow lens is well made, finely corrected so that no image deterioration is sustained. Short focal length allows the lens to be used closer to the primary focus, thus making it convenient to use as part of the eyepiece system. Short focal length also insures that the total length of the telescope will not be increased an impracticable amount.

Direction sheets on the use and the mounting of the Barlow lens are available.

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OBSERVER'S PAGE

Universal time is used unless otherwise noted.

A Naked-eye Method for Finding Venus by Day

SEEN as a pinpoint of light against the blue daytime sky, the planet Venus is one of the most interesting sights in the heavens. When near its greatest brilliancy, it can be readily seen with no optical aid, if only one looks in the right direction. The sky must be a clear, deep blue, since the scattered light from even a slight haze is enough to impair the visibility of Venus seriously. Although usually harder to find than the proverbial needle in the haystack, under favorable conditions our neighbor planet is surprisingly conspicuous to the naked eye.

A direct method for finding Venus in the daytime is to obtain a table of positions from the **American Ephemeris** and use a telescope equipped with setting circles to locate the proper point in the sky. Then, after the planet has been seen within the field of the telescope, the observer can sight along the length of the tube for naked-eye observation.

But not all of us have properly mounted instruments with setting circles, and often we wish to see Venus by day without any instrumental aid. The method described here is to observe on the preceding night a reference star whose declination is approximately that of Venus, so that the star and Venus are almost equally distant from the north celestial pole. Their daily circles across the sky will therefore be nearly the same, and their difference in right ascension, Venus minus star, tells the time interval by which Venus will lag behind the star.

At night, then, line up the star with a flagpole, chimney, tree, corner of a building, or the like, making a reference mark on the ground at your observing location. Return to this same spot after the proper interval, and Venus will be marked off in the sky. The exact time of observation of the star is immaterial, within rather wide limits, since the time lag is added to whatever observation time is selected by the observer.

It is well to choose a time when the star has an altitude of at least 20 degrees, to insure clear atmosphere for detecting Venus at the same height. It is also necessary to observe the star at least three hours before its setting, so the subsequent sighting of Venus will not be made after evening twilight has begun. Some observers may wish to make half-hourly sights, each with its reference mark on the ground, to facilitate a protracted watch on Venus the next day.

For example, suppose you wish to find Venus by day on August 4th. For the 3rd the ephemeris with this article gives Delta Aquilae, magnitude 3.4, as the star to use, and the lag as 16 hours 18 minutes. On the evening of the 3rd, the star is lined up with a terrestrial landmark at, say, 9:37 p.m. Venus will be in nearly the same place in the sky 16 hours 18 minutes later, or at 1:55 p.m. on the 4th.

Later in the month, as the declination of Venus becomes more southerly, other finder stars must be used. All six stars can be found in the star map on page 359 of this issue, but two are not labeled there. Theta Aquilae is the star just to the left of Eta, and Lambda Aquilae is the star farther to the right and south of the latter.

Circumstances favor searching for Venus now and for several months to come. The planet reaches greatest eastern elongation on September 6th, and greatest brilliance occurs October 11th. Its apparent magnitude on August 1st is −3.6, on September 1st, −4.0. Even at inferior conjunction on November 15th, when it changes from an evening to a morning star, Venus is only a magnitude fainter. Greatest brilliance occurs again on December 21st, and greatest western elongation on January 25, 1955. During December and January it will be possible to see Venus in the early dawn and to follow it into broad daylight.

From what has been said, anyone familiar with the **American Ephemeris** can make up his own list of finder stars. The important thing is to choose a star whose declination is close to that of Venus on the observing date; the stars listed here have declinations within two degrees of the planet's. From a table of moon positions, a similar ephemeris can be made for the dates each month when Venus and the moon have nearly equal declinations, and the moon itself can be observed in the daytime when it is not too near the sun. The moon, however, moves rapidly, so that its position must be known for the time of observing it to determine the lag of Venus.

Delta (δ) Aquilae, 3.4: July 31, 16:06, N; Aug. 1, 16:10; 2, 16:14, S; 3, 16:18, S; 4, 16:22, S; 5, 16:26, S.

Theta (θ) Aquilae, 3.4: Aug. 5, 15:41, N; 6, 15:44, N; 7, 15:48, N; 8, 15:52, N; 9, 15:56; 10, 16:00, S; 11, 16:04, S; 12, 16:08, S; 13, 16:11, S.

Lambda (λ) Aquilae, 3.5: Aug. 13, 17:16, N; 14, 17:20, N; 15, 17:24, N; 16, 17:28, N; 17, 17:32; 18, 17:35, S; 19, 17:39, S.

Beta (β) Aquarii, 3.1: Aug. 17, 15:06, N; 18, 15:10, N; 19, 15:14; 20, 15:18, S; 21, 15:22, S; 22, 15:25, S.

Epsilon (ε) Aquarii, 3.8: Aug. 23, 16:13, N; 24, 16:17, N; 25, 16:20, N; 26, 16:24, N; 27, 16:28; 28, 16:32, S; 29, 16:35, S; 30, 16:39, S.

Alpha (α) Capricorni, 3.8: Aug. 29, 17:04, N; 30, 17:08, N; 31, 17:12, N; Sept. 1, 17:15, N; 2, 17:19; 3, 17:22, S; 4, 17:26, S; 5, 17:30, S; 6, 17:33, S.

In the table, each star's magnitude is given; then, for the date of the star observation, the planet's lag after the star in hours and minutes. The letter **N** indicates that Venus has a more northerly declination than the star; **S** that the planet is somewhat south of the star; the symbol is omitted on the day for which Venus and the star have nearly the same declination.

The kind of time used by the observer is immaterial; it may be local, standard, or daylight saving. (The lag has been corrected for the difference between sidereal and solar time.)

For the next few months the Observer's Page will carry lists of finder stars similar to this one, based on material supplied by the writer.

FRANKLIN MILLER, JR.
Kenyon College
Gambier, Ohio

MINIMA OF ALGOL

August 3, 8:39; 6, 5:27; 9, 2:16; 11, 23:05; 14, 19:53; 17, 16:42; 20, 13:31; 23, 10:19; 26, 7:07; 29, 3:56. September 1, 0:45; 3, 21:33; 6, 18:21.

These minima predictions for Algol are based on the formula in the 1953 International Supplement of the Cracow Observatory. The times given are geocentric; they can be compared directly with observations.

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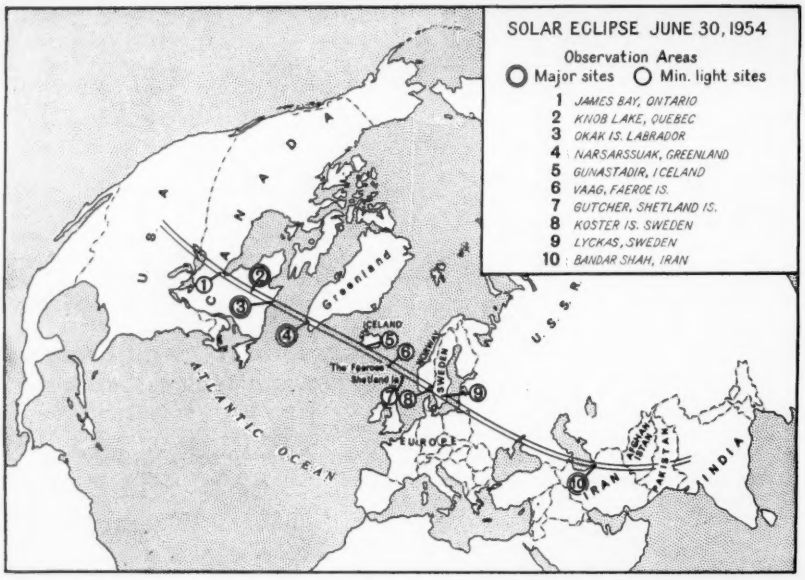


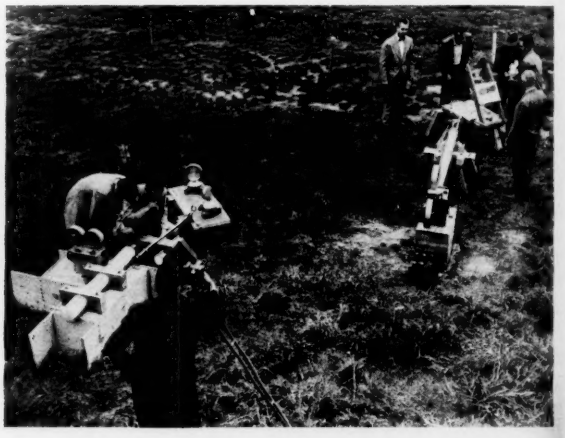
A MAGNIFICENT ECLIPSE

(Continued from page 330)

blad method; motion pictures of the crescent just before and after totality, the Bonsdorff method; and the Gaviola or minimum light method, where a photoelectric cell is used to find the mid-moment of obscuration. The first and second require a clear sky, but the third is applicable, in theory, through a uniform overcast. All three methods were to be used at four major sites, in Quebec, Labrador, Greenland, and Iran; at the remaining stations only the minimum light observations were planned.

At Knob Lake, Que., and the Okak Islands, Labrador, overcast made visual observations impossible, but the minimum light work gave some results. In Greenland, cloudy skies prevented Lindblad and Bonsdorff observations; at Iran, where the weather prospects had appeared excellent, it was also cloudy, but in both places the minimum light program was carried out. The reception of radio time signals and other arrangements were entirely satisfactory, as far as is now known, but it appears that unfavorable weather has seriously limited the success of the Air Force program.

Above: The locations of Air Force expeditions along the path of the total eclipse.



Right: Eclipse equipment for the Lindblad method (left) and the Bonsdorff method, set up on the Ohio State University campus at Columbus for a rehearsal. Both instruments use coelostats to throw sunlight into the horizontal tubes. Ohio State University photo.

Several expeditions had as their principal objective photography of the flash spectrum, the bright-line spectrum of the solar chromosphere that is briefly visible when the moon just covers the sun's bright photosphere completely.

At Hansen, Ont., near Hearst, Dr. K. O. Wright, of the Dominion Astrophysical Observatory, in company with P. E. Argyle and John Galt, had arranged for slitless spectrograms of the flash spectrum between 3500 and 4600 angstroms. Dr. Wright wired *Sky and Telescope*: "Sky completely overcast during eclipse at Hansen for Victoria party."

The expedition of the David Dunlap Observatory was located at Mattice, Ont., and included a six-man team under the leadership of Dr. J. F. Heard. In addition to flash-spectrum equipment, they brought a battery of four identical telescopes to measure polarization of the light of the corona, in blue and infrared light, and direct photographs were to be taken with an 11-foot camera. Dr. A. R. Sandage, of Mount Wilson and Palomar Observatories, and Dr. F. Shirley Jones, Buffalo University, were among the observers. The weather was cloudy, the low ceiling preventing even the takeoff of a standby plane that had been provided by the Toronto *Daily Star*.

The ground expedition of the Dominion Observatory went to Smoky Falls, Ont., under the leadership of Dr. C. S. Beals. They had a large grating spectrograph with a dispersion of one angstrom per millimeter and Fabry-Perot interferometers, to measure widths of

William Seaman photographed the eclipse at five-minute intervals from the Mendota Bridge at Minneapolis, with a Speed Graphic camera and 12-inch telephoto lens. The exposure showing the corona was 1/50 second at f/5.6; the partial phases were taken through a No. 4 filter, 1/200 second at f/16. Minneapolis Star photograph.

the chromospheric emission lines. They were completely clouded out, but the airborne party, arranged by the National Research Council of Canada and the RCAF, was successful. This group included Dr. P. M. Millman, Dr. A. E. Douglas, and Prof. J. E. Kennedy. Dr. Beals writes that they obtained ultraviolet spectra of the corona and the flash spectrum; the plane was at 27,500 feet, at approximately 57° 40′ north latitude and 61° west longitude.

Along the east coast of Sweden, on Oland Island, French observers were prepared for intensive observations during 2½ minutes of totality, as described by Miss Sarah Lee Lippincott in the June issue (page 261). After the eclipse, she cabled from Lottorp, Sweden: "West Sweden Gotland Island clear, interior clouds, corona seen through clouds on Oland."

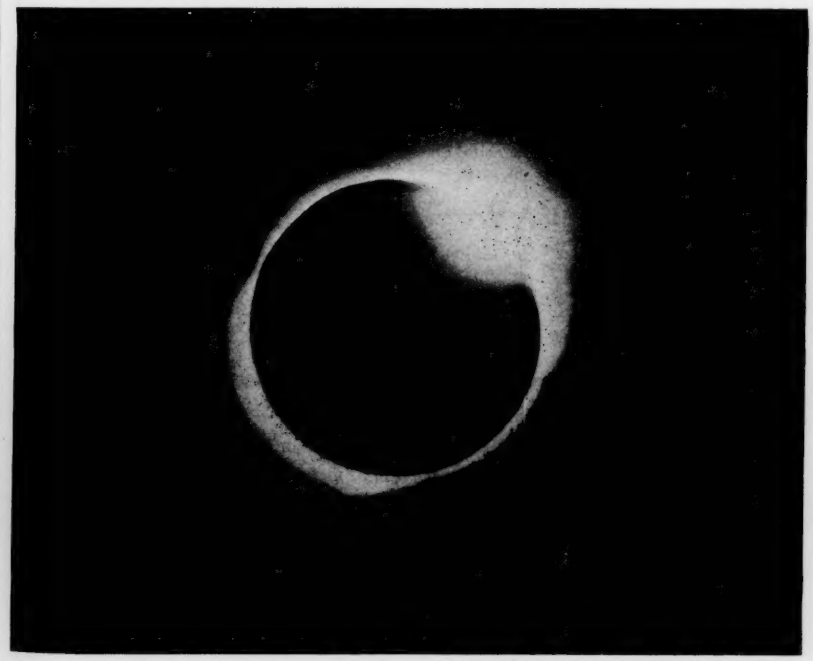
Near the eastern end of the path, at Mastung in Pakistan, Dr. Charles H. Smiley, of Brown University, successfully carried out zodiacal light observations, according to press reports. In nearby Quetta, photographs were taken at Pakistan Geophysical Observatory.

An unusual expedition was that of Dr. Dean B. McLaughlin and his wife, who drove around the western end of Lake Superior, thence east 370 miles to road's end at Marathon, Ont., not far from the central line of the shadow. The Michigan astronomer telegraphed: "Set cameras near Heron Bay. Overcast throughout eclipse."

The expedition of Dr. A. E. Whitford, Washburn Observatory, University of Wisconsin, who traveled to Mellen, Wis., had perfect skies. An outstanding amateur gathering was at Cumberland, Wis., where 60 members of the Popular Astronomy Club, Moline, Ill., encouraged a turnout of several hundred local residents. The eclipse bus tour attracted 53 members of the Astronomical League; their observing site four miles west of Copper Harbor was hampered by fog that permitted a view of the corona for only a few seconds.

From airplanes, attempts were made to view the aurora, following the suggestion of Sydney Chapman and D. W. N. Stibbs in *Sky and Telescope* for December, 1953. A Royal Canadian Air Force Lancaster bomber, based on Summerside, Prince Edward Island, was aloft for this purpose. Squadron Leader J. A. White states that while the weather was clear and all observers aboard could see stars during totality, none could see an aurora. Their impression was that the sky was far too bright to observe a weak aurora.

South and west of Greenland, at 25,700 feet, five members of a joint Air Force-Bureau of Standards expedition searched for auroral light from a B-29 bomber. The scientific personnel included Drs. Dana K. Bailey, F. E. Roach, and Ralph Slutz, of the Bureau of Standards, Dr. P. St. Amand, Naval Ordnance Test Station, and Dr. Bruce Billings, of Baird Associates. No aurora was evident either by direct view or through filters transmitting the green auroral line at 5577 angstroms. The principal purpose of the flight was achieved, however, with photometers designed by Dr. St. Amand to measure the brightness of the zenith sky during totality at four wave lengths.



This diamond ring was formed by the first bit of sunlight emerging at the end of totality while the inner corona could still be seen. A 3-inch lens was used at f/18, ½-second exposure on Superpan Press, by D. C. Dornberg, St. Paul Dispatch and Pioneer Press.

SUNSPOT NUMBERS

American numbers for May, communicated by the AAVSO Solar Division, were zero on all dates except May 5, 1; 14, 4; 15, 1. Provisional Zurich numbers, sent by Dr. M. Waldmeier, were 8, 9, and 6 on these days, and zero on every other date in May. Monthly means for May: 0.2 American; 0.7 Zurich.

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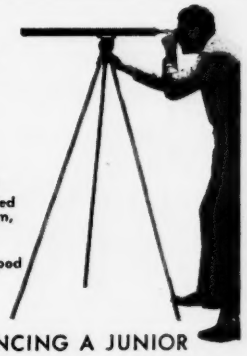

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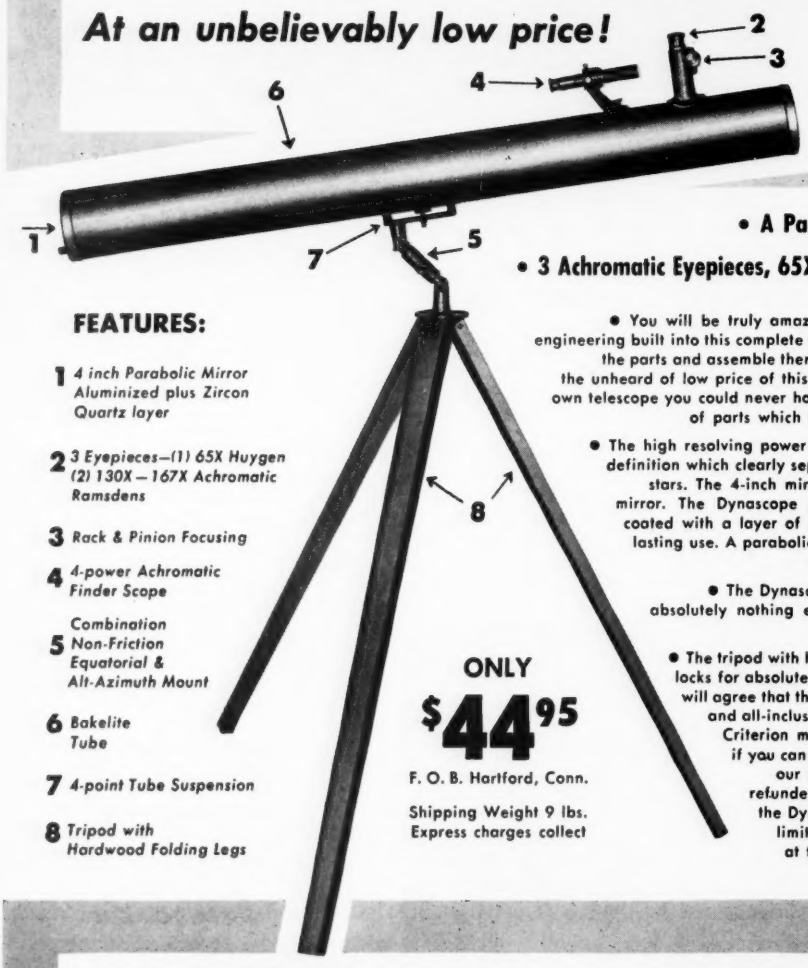

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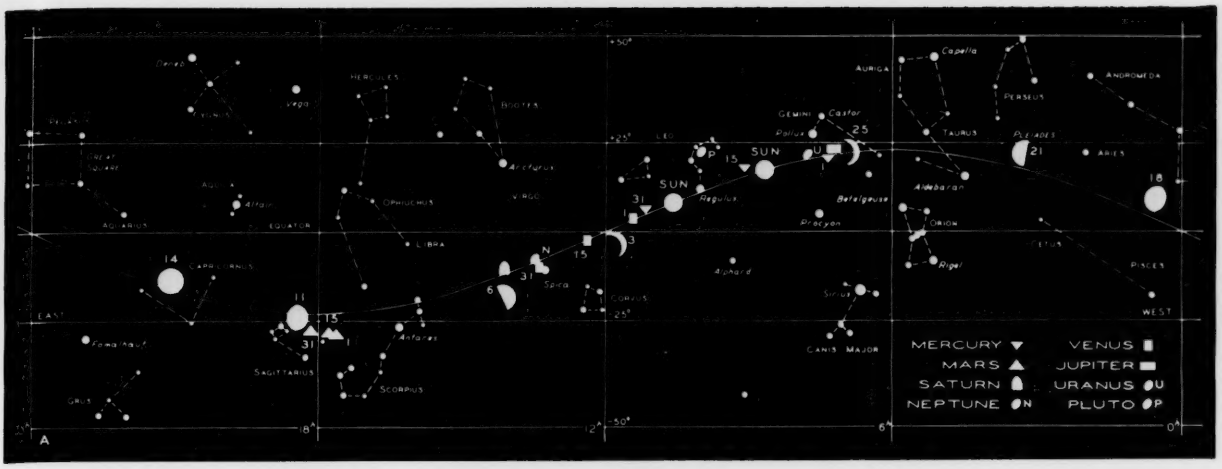

THE SUN, MOON, AND PLANETS THIS MONTH

The sun, on the ecliptic, is shown for the beginning and end of the month. The moon's symbols give its phase roughly, with the date marked alongside. Each planet is located for the middle of the month and for other dates shown.

Mercury may be viewed early in the month in the morning sky. On the 1st it rises 1½ hours before sunrise, and as late as the 12th the planet comes up three quarters of an hour before the sun, at magnitude −1.2.

Venus, setting shortly after evening twilight ends, continues to brighten, and is of magnitude −3.8 on the 15th. Venus is traveling eastward in Virgo, passing only 7′ north of Spica on August 31st. Its telescopic disk is 20″ in diameter and at slightly more than half phase on the 15th.

Mars can be seen low in the southern sky in the early evening. It sets at midnight at the end of August. As it moves eastward in Sagittarius, the planet fades from magnitude −1.7 to −1.0 during the month. The diameter of Mars' disk, 17″ on the 15th, steadily decreases as the planet recedes from the earth.

Jupiter, rising 2½ hours before the sun in mid-August, is of magnitude −1.5. It is moving eastward, south of Castor and Pollux in Gemini. The first eclipse of satellite IV, Callisto, visible to observers in the United States since 1951 will occur on the 19th, when Callisto disappears into Jupiter's shadow about 9:05 UT.

Saturn may be seen in the western sky for three hours after sunset in mid-month. At magnitude +0.9, Saturn is moving eastward in Virgo near the border of Libra. The ring system is inclined 17° to the line of sight, with a longest diameter of 37″ in mid-August.

Uranus, which was in conjunction with the sun in July, again may be seen in the morning sky as a 6th-magnitude object. On August 4th, Uranus will be 35′ north of Mercury, but this conjunction will need optical aid to be observable.

Neptune can be looked for as evening twilight ends, with the aid of the chart on page 137 of the February issue. E. O.

VARIABLE STAR MAXIMA

August 1, R Aurigae, 050953, 7.8; 4, V Ophiuchi, 162112, 7.5; 9, S Gruis, 221948, 7.8; 15, R Andromedae, 001838, 7.0; 15, R Centauri, 140959, 5.9; 15, T Cephei, 210868, 5.8; 26, R Sculptoris, 012233a, 5.8.

These predictions of variable star maxima are by the AAVSO. Only stars are included whose mean maximum magnitudes are brighter than magnitude 8.0. Some, but not all of them, are nearly as bright as maximum two or three weeks before and after the dates for maximum. The data given include, in order, the day of the month near which the maximum should occur, the star name, the star designation number, which gives the rough right ascension (first four figures) and declination (bold face if southern), and the predicted magnitude.

UNIVERSAL TIME (UT)

TIMES used on the Observer's Page are Greenwich civil or Universal time, unless otherwise noted. This is 24-hour time, from midnight to midnight; times greater than 12:00 are p.m. Subtract the following hours to convert to standard times in the United States: EST, 5; CST, 6; MST, 7; PST, 8. If necessary, add 24 hours to the UT before subtracting, and the result is your standard time on the day preceding the Greenwich date shown.

AUGUST METEORS

The Perseid stream, best of the annual meteor showers, may be observed the first half of August. Unfortunately, at the shower's maximum on August 11-13, the moon will interfere seriously, the full phase occurring on the 14th, in Capricornus. However, many Perseids are bright, and the shower is worth observing even in strong moonlight. Under favorable conditions, up to 50 Perseids may be counted per hour after midnight. At the time of maximum, the slowly moving, diffuse radiant is north of Eta Persei.

It will be advantageous to look for these swift meteors earlier in the month as well, when the moon interferes less. On the 8th, the moon sets about midnight, and around that date one should be able to see numbers of Perseids. E. O.

MOON PHASES AND DISTANCE

First quarter	August	6, 18:50
Full moon	August	14, 11:03
Last quarter	August	21, 4:51
New moon	August	28, 10:21
First quarter	September	5, 12:28

			Distance	Diameter
	August			
Apogee	6,	3h	251,200 mi.	29′ 33″
Perigee	18,	6h	228,200 mi.	32′ 32″
	September			
Apogee	2,	22h	251,600 mi.	29′ 30″

OCCULTATION PREDICTIONS

August 12-13 **Rho Capricorni** 5.0, 20:26.2 −17-58.0, 14, Im: **A** 6:42.8 −1.0 −0.6 71; **B** 6:40.3 −0.9 −0.4 62; **C** 6:39.4 −1.3 −0.5 74; **D** 6:35.2 −1.0 −0.1 58; **E** 6:21.3 −1.3 +0.5 49; **F** 6:04.2 −1.9 +0.8 57; **H** 5:40.0 −1.1 +2.8 12.

August 22-23 **132 Tauri** 5.0, 5:46.2 +24-33.2, 24, Em: **A** 6:24.5 −0.6 −0.2 319; **B** 6:21.5 ... ... 336; **C** 6:22.4 −0.4 −0.1 315.

September 18-19 **132 Tauri** 5.0, 5:46.2 +24-33.2, 22, Em: **H** 12:49.1 −2.2 −0.1 281.

For stations in the United States and Canada, usually for stars of magnitude 5.0 or brighter, data from the **American Ephemeris** and the **British Nautical Almanac** are given here, as follows: evening-mo.ning date, star name, magn.-tude, right ascension in hours and minutes, declination in degrees and minutes, moon's age in days, immersion or emersion; standard station designation, UT, **a** and **b** quantities in minutes, position angle on the moon's limb; the same data for each standard station westward.

The a and b quantities tabulated in each case are variations of standard-station predicted times per degree of longitude and of latitude, respectively, enabling computation of fairly accurate times for one's local station (long. Lo, lat. L) within 200 or 300 miles of a standard station (long. LoS, lat. LS). Multiply a by the difference in longitude (Lo — LoS), and multiply b by the difference in latitude (L — LS), with due regard to arithmetic signs, and add both results to (or subtract from, as the case may be) the standard-station predicted time to obtain time at the local station. Then convert the Universal time to your standard time.

Longitudes and latitudes of standard stations are:

A	+72°.5,	+42°.5	**E**	+91°.0,	+40°.0
B	+73°.6,	+45°.5	**F**	+98°.0,	+31°.0
C	+77°.1,	+38°.9	**G**	Discontinued	
D	+79°.4,	+43°.7	**H**	+120°.0,	+36°.0
			I	+123°.1,	+49°.5

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WANTED: 12″ reflectors or refractors, also several 6″. Telescopes must be in good condition. Send photo and price. F. W. Manning, 4321 Perrier St., New Orleans 15, La.

FOR SALE: 10″ f/6.4 Newtonian telescope, suitable for school or serious private observer. For concrete pedestal mounting. Heavily constructed equatorial, with setting circles. Steel 12″ cork-insulated tube. Valued at $1,200.00. For information or appointment: R. S. Luce, 168-73rd St., Brooklyn 9, N. Y.

SPECIAL: New telescope mirrors, finest quality, 6″, 8″, 10″ pyrex mirrors, f/8 only, with elliptical pyrex diagonals, all aluminized and quartz over-coated, $60.00, $92.50, $160.00 postpaid. Finest performance guaranteed. Rapid delivery. Cave Optical Co., 4137 E. Anaheim Blvd., Long Beach 4, Calif.

FOR SALE: 10″ parabolic mirror with aluminum cell, made by Precision Optical Supply Co., New York. Never been used, due to death. $135.00. Mrs. Verne Swaim, 2412 Main St., Peoria, Ill.

FOR SALE: 7¼″ Mellish refractor, f/14; 3 small edge chippings; 5 eyepieces; pipe tripod equatorial mounting without drive. Bargain $750.00. W. E. Johnson, 6209 Fairfield Ave., Chicago 45, Ill.

GOVERNMENT SURPLUS: 6 telescopes, precision built, 12 and 25 power, eye lens ½″ diameter, field lens 3″ diameter. Acquired cost to Government $1,000.00 each. Sacrifice $75.00 each delivered. Send check for immediate shipment. Crown Equipment Co., 1011 Bleury, Montreal, Que.

TELESCOPES, BINOCULARS, Microscopes. Complete line of quality optics for amateur telescope makers. Write—Harold Snyder, 705 Leopold St., Huntington, Ind.

FOR SALE: 3″ Japanese (Goto) refracting telescope, excellent definition. Focal length, 4 feet. With 30x terrestrial eyepiece; astronomical eyepieces of 48x, 100x, and 200x; zenith prism; special solar image projector. Equatorial mounting with two fine adjustments for polar axis and two slow motions. Very steady tripod. White tube, black mounting, chrome finish on all exposed metal. Practically new. Address Mrs. C. Stewart, P. O. Box 5255, Tucson, Ariz.

REFLECTOR, 6″ diameter, 75″ f.l., wooden tube, 3 eyepieces, sturdy tripod, $60.00 f.o.b. 4″ refractor, 60″ f.l., 5 eyepieces, finder, good tripod and wooden case, $350.00 f.o.b. Samuel Linn, Box 254, Morrill, Neb.

"RELATIVITY and Atomic Energy." Classroom price 50c each in quantities of six or more. Wm. I. Barnholth, 2060 17th St. SW, Akron 14, Ohio.

SPACE-ROVER astronomical telescopes, precision made, professionally equipped. Sans and Streiffe, Unitron. Buy — sell. Books. Rasmussen and Reece, Amsterdam, N. Y.

"THE SUN," edited by Kuiper, $12.50; Norton's "Star Atlas," $5.25; Moore, "Guide to the Moon," $3.95; Minnaert, "Light and Colour in the Open Air," $3.95. All domestic and foreign publications. Write for new list. Herbert A. Luft, 42-10 82nd St., Elmhurst 73, N. Y.

WANTED: 3″ or 4″ refractor or 6″ to 8″ reflector type telescope in A-1 condition. Give full description. Photo appreciated. W. G. Prather, 1011 W. 5th, Freeport, Tex.

MOUNTED 5″ and 6″ refractor objectives of first quality. $200.00 and $300.00. 4″ edged blanks, $22.50. Correspondence invited. Earl Witherspoon, Sumter, S. C.

PRICED for quick sale! Brand new 6″ f/8 Newtonian reflector. Quartz over-coated mirror, two Ramsden eyepieces, ½″ and ¼″, rack and pinion, equatorial mounting and a sturdy tripod, $100.00. Contact Ronald Trost, 2250 Emerson Ave., Dayton 6, Ohio.

FOR SALE: 4″ altazimuth Unitron complete. Purchased from manufacturer in May last. Due to ill health will sacrifice to best offer. G. O'Hare, 637-60th St., Brooklyn 20, N. Y.

FOR SALE: 6″ reflector, f/7, excellent optics and mechanics; easy, positive adjustments and focusing. $60.00 shipping paid. John McQuaid, 2003 High St., Logansport, Ind.

THE ECLIPSE FROM THE AIR

(Continued from page 334)

5:07:39. Dr. Menzel then returned to his own equipment and silence settled over the waiting group. The solar crescent was now very thin, and a strange yellowish color covered the sky. I risked a second to glance down at the earth. The ground haze now appeared as yellow-gray as the sky above us, and toned down and obscured the earth colors.

The darkness was now creeping swiftly upon us. Cabin lights had been extinguished, the plane was running on automatic pilot, and now the seconds count began. I held the direct-vision spectroscope in my hands and hoped I would not succumb to the "buck fever" that has caused some first observers to look away and miss the corona completely. I was afraid to look west and hence missed the approach of the shadow. At 5:07:33 I raised the spectroscope to my eye, and saw the continuous spectrum and the absorption lines for a few seconds before the bright lines suddenly appeared. I was able to distinguish many of the hydrogen lines and the coronal line, but the seconds were ticking inexorably away and I had not yet seen the corona itself. I handed the spectroscope to my seat companion and for a few precious seconds simply stared at the beautiful sight for which no description can prepare one.

It was a perfect sunspot-minimum corona. Long pearly-white streamers shot out equatorially far from the sun's surface. With a small strip of cardboard I measured the sun's disk, and stepped it off against the longer, western streamer. I made it about 2½ solar diameters or two million miles. The eastward arm was appreciably shorter. I caught a glimpse of one prominence in about the 7 o'clock position, and had begun to scan for others when, with blinding suddenness, the diamond ring appeared, and I remained gazing at it long enough to miss the passage of the shadow.

At totality the sky was not sharply black, but seemed filled with a smoky-gray tangible substance. The eastern edge of the shadow cone was plainly visible, and the effect was of being suspended in a cone of smoke, not unlike a parachute.

Dr. Menzel made photographs of the corona, some through polaroid. Other Harvard astronomers, Dr. H. Zirin and J. Wolbach, photographed the flash spectrum with a movie camera to which a diffraction grating was fitted.

As the partial phases were resumed, tension dropped for viewers on the plane. Most remained silent, still absorbed by the spectacle they had witnessed. For most first viewers there was a frustrated feeling that we should have managed to see more in the precious time allotted. At 5:30 we began to descend. Once more at the Minneapolis airport, we lingered over breakfast to compare impressions.

Soon the Stratocruiser took off again, on its regular New York run, with the Harvard astronomers and their precious films on board—the plane still bearing its "Solar Eclipse Flight" insignia.

TOTAL ECLIPSE WEATHER IN THE UNITED STATES

(Continued from page 327)

From the Porcupine Mountains in Michigan eastward, Lake Superior played an unfriendly part. Bands of cloud divided by clear spaces moved eastward after the passage of thunderstorms. At the Houghton, Mich., airport on the base of the Keweenaw peninsula, storm clouds moved off eastward and skies overhead were clear until fog rolled in off Lake Superior. It was so dense that eclipse observing planes could not take off. On the lake itself, heavy fog prevented observations from shipboard.

From the Porcupine Mountains state park, on the shore of Lake Superior, this cloud bank hid the eclipse. Farther west, at Ramsey, Mich., the sun cleared the cloud deck in time for totality. Photograph by J. M. Spooner.

UNITRON

From our Mailbag . . .

"I have received today your 7-mm. UNITRON Refractor eyepiece for use with my reflecting telescope with a 5″ f/12 mirror of 60″ focal length. I tried it out tonight and I was utterly amazed. Although it was a rather hazy night I saw Titan, Saturn's largest satellite. I never could see it with my telescope even on an extra clear night, with the eyepieces I originally had. The eyepiece is extraordinarily excellent. I regret very much that I did not buy a UNITRON Refractor in the first place. Also I would like to thank you for the amazing promptness with which you handled my order."

G. L., Brooklyn, N. Y.

SEE the outside back cover

United Scientific Co.

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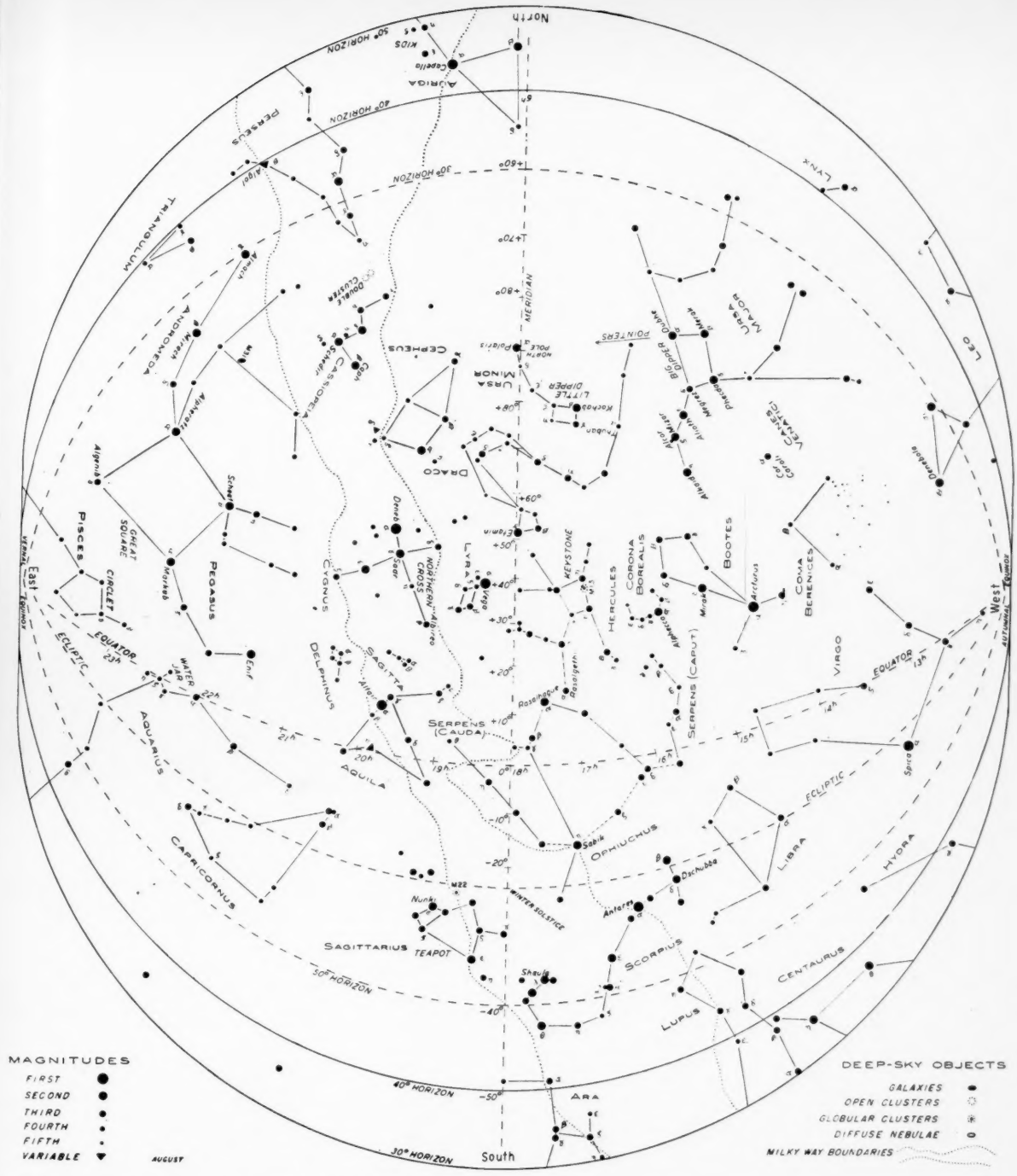

The sky as seen from latitudes 30° to 50° north, at 9 p.m. and 8 p.m., local time, on the 7th and 23rd of August, respectively.

STARS FOR AUGUST

NEARLY OVERHEAD at chart times on August evenings is the brilliant white star, Vega. A skygazer whose latitude is close to that of Washington, D. C., or St. Louis, Mo., can see it pass nearly through the zenith. The other stars of the constellation Lyra, though much less conspicuous, include several interesting objects.

Persons with unusually sharp vision can recognize 4th-magnitude Epsilon (ε) Lyrae, near Vega, as a close pair of stars, only 3½ minutes of arc apart. Epsilon is also a very sensitive test for astigmatism; this optical defect is present in your vision if you see Epsilon Lyrae merely elongated and the direction of elongation shifts as you twist your head. The pair of stars is a fine field-glass object, and a good telescope resolves each member of the pair into two stars—the famous double double of Lyra.

Beta (β) Lyrae is one of the most famous variable stars in the heavens, changing regularly between magnitudes 3.4 and 4.3. It is an eclipsing variable, with a period of 12 days 22 hours. When brightest it matches its neighbor Gamma (γ) Lyrae, and at minimum it is slightly fainter than Zeta (ζ). Note the brightness of Beta particularly on the evenings of August 2nd, 15th, and 28th, when it will be at its faintest. On these dates, the larger, brighter member of this eclipsing pair will be partly hidden behind its smaller and fainter mate. Midway between these dates, Beta will be slightly dimmed, to magnitude 3.8, as the fainter star is masked in its turn. Following these changes is easy for beginners.

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The UNITRON 4" Photographic Equatorial

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In an unbelievably short time, the UNITRON 4" Equatorial Refractors have firmly established themselves as the overwhelming choice of university observatories, the U. S. Government, and discriminating amateur astronomers everywhere.

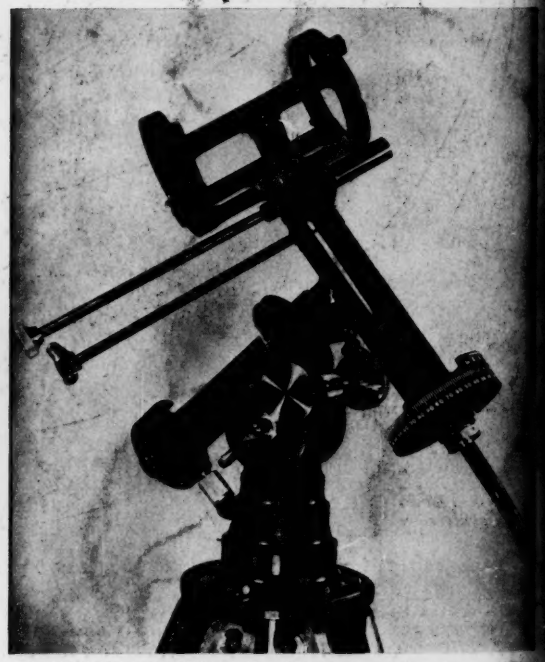
This enviable reputation has been built by the outstanding quality and value of the instruments themselves — their superior performance, precision workmanship, and modern design.

MODEL 155 COMPLETE as illustrated with equatorial mounting and tripod, 2.4" photographic guide telescope with star diagonal and crosshair eyepiece, 10x, 42-mm. view finder, 6 eyepieces, sun projecting screen, sunglass, solar aperture diaphragm, star diagonal, erecting prism system, dewcap, dustcap, pocket eyepiece case, wooden cabinets, etc. **Only $890**

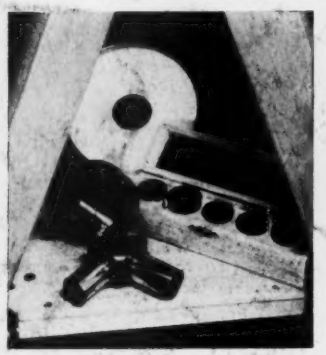
MODEL 152 as above but without guide telescope **Only $785**

An ASTRO-CAMERA and CLOCK DRIVE are in the final design stage and will be available shortly as separate accessories. A FIXED METAL PIER will be offered for permanent installation.

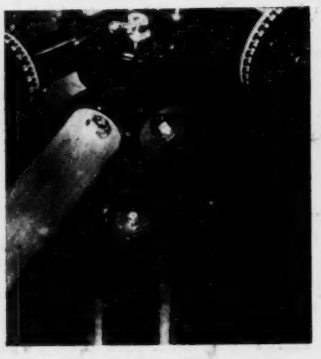
Large 10x, 42-mm. (1.6") VIEW FINDER.



EQUATORIAL MOUNTING with micrometric slow motion controls for both R. A. and declination, setting circles and verniers, and latitude adjustment.



TRIPOD SHELF holds eyepieces and accessories while observing.



Battery-operated LAMP casts a reddish light on the shelf.

Use our time payment or lay-a-way plans to obtain a large telescope right from the start! No red tape — application form available on request. And if you haven't already received a copy of our free catalog, we should be happy to rush one to you. A special section tells you how to choose a telescope. All instruments fully guaranteed. Shipment via express collect. Send check or money order or 25% deposit with balance C.O.D. Write to Dept. TC-8.

. . . and there are 8 other UNITRON Models to choose from!

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